INSTALLATION RESTORATION PROGRAM

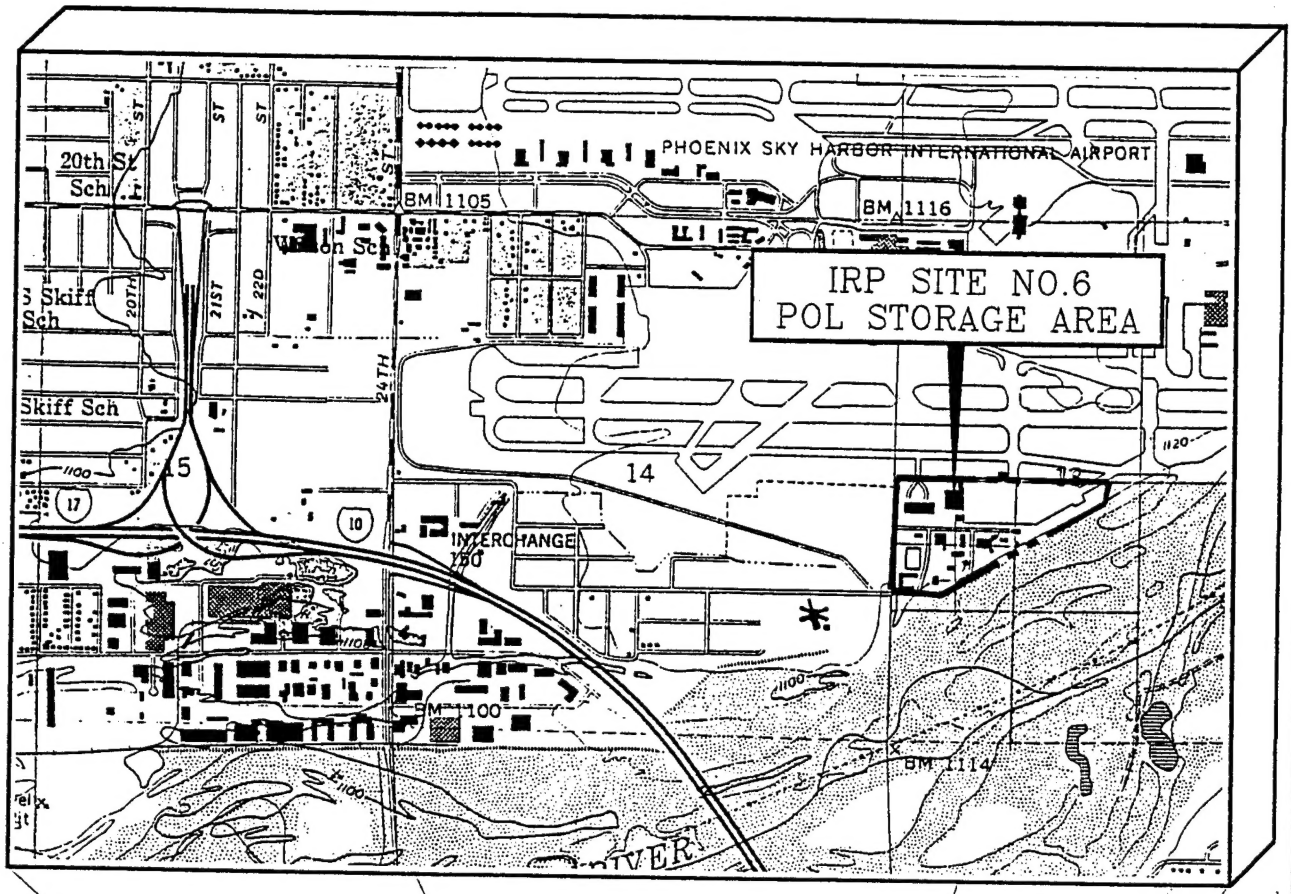
REMEDIAL INVESTIGATION REPORT ADDENDUM FOR IRP SITE NO. 6

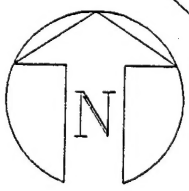
VOLUME I

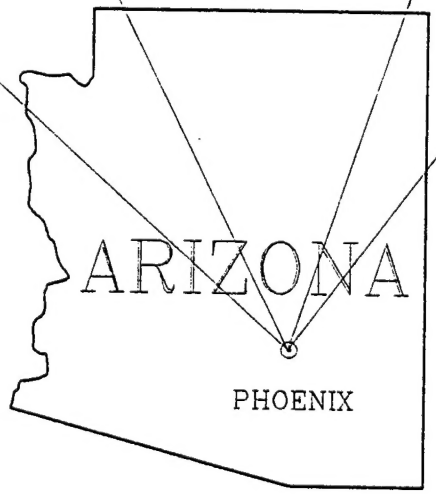
161st AIR REFUELING GROUP
ARIZONA AIR NATIONAL GUARD
SKY HARBOR INTERNATIONAL AIRPORT
PHOENIX, ARIZONA

MAY 1996

HQ ANG/CEVR
ANDREWS AFB, MARYLAND







LEGEND

Base Boundary

0 1000 2000

SCALE IN FEET

INSIDE FRONT COVER

SKYHARBO\SKY2-118

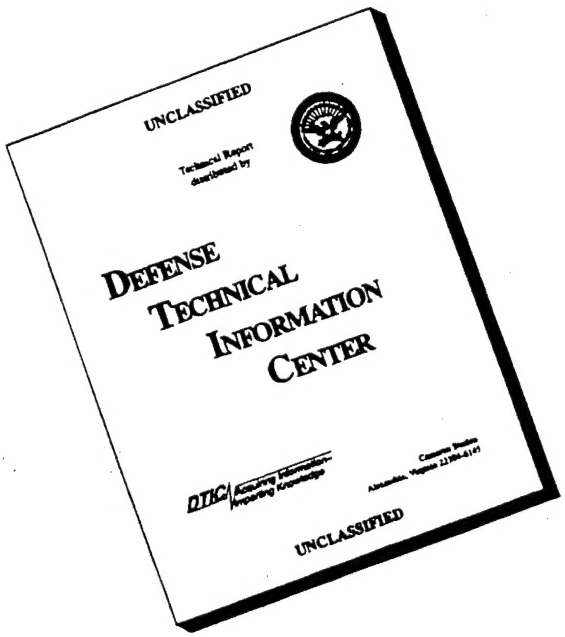
STATE LOCATION MAP

161st ARG, Arizona Air National Guard
Sky Harbor International Airport
Phoenix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

MARCH 1996

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE MAY 1996	3. REPORT TYPE AND DATES COVERED Remedial Investigation Report

4. TITLE AND SUBTITLE
Remedial Investigation Report Addendum for IRP Site No. 6, Volume I
Arizona National Guard, 161st Air Refueling Group, Sky Harbor International Airport, Phoenix, Arizona

5. FUNDING NUMBERS

6. AUTHOR(S)
NA

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Operational Technologies Corp.
4100 N.W. Loop 410, Suite 230
San Antonio, TX 78229-4253

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
ANG/CEVR
3500 Fetchet Avenue
Andrews AFB MD 20762-5157

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release;
distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Remedial Investigation Report Addendum for IRP Site No. 6, Arizona National Guard, 161st Air Refueling Group, Sky Harbor International Airport, Phoenix, Arizona. This is the first volume of a two volume addendum to the Remedial Investigation Report, May 1996. Site 6 - POL Facility was investigated under the Installation Restoration Program. Soil and groundwater samples were collected and analyzed. Remedial Action was recommended for both groundwater and soil associated with the site.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Installation Restoration Program; Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); Air National Guard; Remedial Investigation,Arizona Air National Guard, Phoenix, AZ	167
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	None

INSTALLATION RESTORATION PROGRAM

REMEDIAL INVESTIGATION REPORT ADDENDUM FOR IRP SITE NO. 6

VOLUME I

161st AIR REFUELING GROUP
ARIZONA AIR NATIONAL GUARD
SKY HARBOR INTERNATIONAL AIRPORT
PHOENIX, ARIZONA

MAY 1996

Prepared For

HQ ANG/CEVR
ANDREWS AFB, MARYLAND

Prepared By

Operational Technologies Corporation
4100 N.W. Loop 410, Suite 230
San Antonio, Texas 78229-4253
(210) 731-0000

1315-273

TABLE OF CONTENTS

VOLUME I

TABLE OF CONTENTS (Continued)

VOLUME I

VOLUME II

TABLE OF CONTENTS (Concluded)

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS

AALs	ADEQ Action Levels
ADEQ	Arizona Department of Environmental Quality
ADHS	Arizona Department of Health Services
AGE	Aerospace Ground Equipment
ANG	Air National Guard
ANG/CEVR	Air National Guard/Installation Restoration Program Branch
ANGRC	Air National Guard Readiness Center
ARARs	Applicable or Relevant and Appropriate Requirements
ARG	Air Refueling Group
ASTM	American Society of Testing and Materials
AZANG	Arizona Air National Guard
BH	Borehole
BLS	Below Land Surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CEVR	Installation Restoration Program
cm/sec	centimeter per second
CFU/g	Colony forming units per gram
DCA	Dichloroethane
DCE	Dichloroethylene
EWA	East Washington Area
° F	Degree Fahrenheit
FS	Feasibility Study
gal/day/ft^2	gallons per day per foot squared
GC	Gas Chromotograph
HQ	Headquarters
ID	Inside diameter
IRP	Installation Restoration Program
IT	IT Corporation
JP-4	Jet fuel
mhos	millimhos
mL	milliliters
mph	miles per hour
m/sec	meters per second
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MSL	Mean sea level
μg/L	Micrograms per liter
MW	Monitoring well
NGB	National Guard Bureau
OpTech	Operational Technologies Corporation
PA	Preliminary Assessment
PCE	Tetrachloroethylene
PID	Photoionization detector
POL	Petroleum, Oil, and Lubricants

LIST OF ACRONYMS (Concluded)

PPE	Personal protective equipment
ppm	parts per million
RI	Remedial Investigation
QA/QC	Quality Assurance/Quality Control
SI	Site Investigation
RISM	Standard Method
SVOCs	Semivolatile Organic Compounds
TCA	Trichloroethane
TCE	Trichloroethylene
TOC	Top of casing
TPH	Total Petroleum Hydrocarbons
USAF	United States Air Force
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USTs	Underground Storage Tanks
VOCs	Volatile Organic Compounds

REMEDIAL INVESTIGATION ADDENDUM
FOR INSTALLATION RESTORATION PROGRAM SITE NO. 6

EXECUTIVE SUMMARY

This Addendum to the Remedial Investigation (RI) Report presents the results of investigation activities conducted between 19 June 1995 and 10 August 1995 at Installation Restoration Program (IRP) Site No. 6, the Petroleum, Oils, and Lubricant (POL) Storage Area, 161st Air Refueling Group (ARG), Arizona Air National Guard (AZANG), located at Sky Harbor International Airport, Phoenix, Arizona (Figure 1.1).

Extensive baseline data exists on the 161st ARG from previous IRP environmental investigations. Accordingly, this reports supplements the Remedial Investigation Report for IRP Sites No. 6 and No. 7, 161st Air Refueling Group, Sky Harbor International Airport, Phoenix, Arizona, prepared by Operational Technologies Corporation (OpTech) in August 1995 (hereinafter referred to as the *1995 RI Report*).

An RI was conducted at IRP Site No. 6 and IRP Site No. 7, the Old Oiled Road, to define the vertical and horizontal extent of contamination within the soil and groundwater. Prior to submitting the Draft Final RI Report in December 1995, the Headquarters Air National Guard/Installation Restoration Program Branch (HQ ANG/CEVR) and OpTech determined additional field work was needed to further delineate the plume of contamination migrating from IRP Site No. 6. The investigation at the 161st ARG (also referred to as the base) consisted of the following actions:

- Installation of two additional monitoring wells to further delineate the plume of contamination migrating off-base from the POL Area;
- Installation of four additional monitoring wells in the POL Area to further delineate the horizontal extent of contamination near the center of the site;
- Installation of a monitoring well between and upgradient of monitoring wells MWS-02 and MWS-03 to confirm the presence or absence of contamination migrating on-base from the south;
- Installation of two monitoring wells, one west of Building 23 and one at the southeast corner of the building, to further delineate contamination detected in monitoring wells 06-001MW, 06-002MW, and 06-010MW;

- Collection of two rounds of groundwater sampling from newly installed monitoring wells to coincide with quarterly sampling of existing monitoring wells at the base; and

- Collection of soil samples for microbiological and geotechnical analyses.

The results of the field investigation provides additional technical data needed to support a Feasibility Study (FS) to identify and select the most appropriate Remedial Action for the 161st ARG.

The words *contaminant* and *contamination* are used throughout the text of this section. Contamination, in the context of this report, is defined as the presence of any substance introduced into the environment as a result of man's activities without regard to whether the concentrations have reached levels that may cause a significant level of water quality degradation and does not imply a risk to human health. A contaminant is the substance causing the contamination.

The field investigation was performed in three phases. The first phase was conducted from 19 to 30 June 1995 and consisted of drilling and installing nine monitoring wells, drilling one soil boring, collecting composite soil samples from drill cuttings, collecting soil samples for microbiological and geotechnical analyses, and conducting a percolation test. The second phase was conducted from 10 to 14 July 1995 and consisted of collecting groundwater samples from 22 monitoring wells. However, the nine newly installed monitoring wells were improperly sampled, and as a result, were resampled during the third phase from 10 to 13 August 1995.

The field investigation was comprised of:

- Drilling and installing nine monitoring wells,

- Drilling one soil boring,

- Lithologic descriptions,

- Collecting ten composite samples from drill cuttings for disposal criteria,

- Collecting two soil samples for microbiological analyses and two soil samples for geotechnical analyses,

- Conducting one percolation test,

- Measuring and recording water-levels and groundwater parameters,
- Collecting 22 groundwater samples, and
- Surveying the soil boring and monitoring well locations.

The 22 groundwater samples were collected from the nine monitoring wells installed during this field effort and 13 monitoring wells installed during previous field programs and sampled as part of a quarterly groundwater sampling program.

Two subsurface soil samples were collected and analyzed for microbiological parameters. The samples were collected from an area of known high contamination based upon the RI results (OpTech, 1995). Soil samples were analyzed for the following microbiological parameters or parameters associated with bioremediation: total heterotrophs (Standard Method (SM) 9215), total hydrocarbon degraders, pH (SM 9040), moisture (SM 2540), nitrate- and nitrite-nitrogen (United States Environmental Protection Agency (USEPA) Method 353.3), and phosphorous (USEPA Method 365.2). The results indicate low levels of microbiological organisms, soil moisture, and nitrate. Phosphorus and nitrite-nitrogen levels are high enough to support microbiologic activity. For bioremediation to be a viable remediation option, it would require microbiologic augmentation.

Permeability and a sieve analysis were performed on soil samples collected from monitoring wells 06-023MW (39.0 – 40.0 feet below land surface (BLS)) and 06-024MW (50.0 – 50.5 feet BLS). Sieve analyses of the soil sample collected from monitoring well 06-023MW at a depth of 39.0 to 40.0 feet BLS shows 88.9 percent pebbles and 11.1 percent sand. Sieve analyses of the soil sample collected from monitoring well 06-024MW at a depth of 50.0 to 50.5 feet BLS shows 95.3 percent cobble and pebbles, 4.2 percent sand, and 0.5 percent silt and clay. These results indicates both soil samples are a sandy gravel. The permeability of the soil sample collected from monitoring well 06-023MW at a depth of 39.0 to 40.0 feet BLS was determined to be 9.73×10^{-8} meters per second (m/sec) (9.73×10^{-6} centimeters per second (cm/sec)) and the permeability of the soil sample collected from monitoring well 06-024MW at a depth of 50.0 to 50.5 feet BLS was determined to be 4.42×10^{-8} m/sec (4.42×10^{-6} cm/sec). According to the United States Department of Agriculture (USDA), this permeability is very low for a sandy gravel (USDA, 1974). Due to the coarse nature of the substrata it was not possible to collect a complete, undisturbed sample. To compensate, the laboratory substituted a testing method that used an inch cube "plug" for testing. Due to the plug's small size, the size of the gravels and pebbles in the sleeve, the sample was not representative. Therefore, the values reported are erroneously low.

A percolation test was conducted to determine preliminary hydrogeologic data in the vadose zone and used to evaluate discharge options of treated water. Results of the test completed at monitoring well 06-023MW indicated a high infiltration rate of 448 gallons per day per foot squared (gal/day/ft^2).

Twenty-two investigative groundwater samples were submitted for laboratory analysis from the nine newly installed monitoring wells and 13 pre-existing monitoring wells during the July – August 1995 groundwater sampling event. Twenty-two volatile organic compounds (VOCs) – benzene, toluene, ethylbenzene, total xylenes, trichloroethylene (TCE), dichloroethylene (DCE), tetrachloroethylene (PCE), chloroform, carbon tetrachloride, styrene, isopropylbenzene, N-propylbenzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, 1,1-dichloroethane, sec-butylbenzene, P-isopropyltoluene, N-butylbenzene, 1,2,3-trichloropropane, hexachlorobutadiene, chloromethane, and naphthalene – were detected in 21 groundwater samples and four field duplicates. Due to dilution, detection limits were elevated for groundwater sampled from monitoring well 06-021MW.

Benzene was detected in groundwater samples from 17 monitoring wells at concentrations ranging from 0.2 to 4,200 micrograms per liter (μg/L), exceeding the Arizona Department of Environmental Quality (ADEQ) action level of 5 μg/L. Ethylbenzene was detected at concentrations ranging from 0.4 to 750 μg/L, exceeding the ADEQ action level of 700 μg/L in the groundwater sample collected from monitoring well 06-021MW. TCE was detected at concentrations of 0.5 and 7.0 μg/L, exceeding the ADEQ action level of 5 μg/L in the groundwater sample collected from monitoring well 06-016MW.

Toluene, total xylenes, DCE, chloroform, and styrene were detected at concentrations below ADEQ action levels. No ADEQ action levels exist for isopropylbenzene, N-propyl-benzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, sec-butylbenzene, P-isopropyltoluene, N-butylbenzene,1,2,3-trichloropropane,1,1-dichloroethane,hexachlorobutadiene,chloromethane and naphthalene.

Total petroleum hydrocarbons (TPH) were detected at concentrations ranging from one to five parts per million (ppm) in groundwater samples collected from monitoring wells MWS-04, 06-21MW, 06-022MW, 06-023MW, and 06-024MW.

Conclusions based on the RI and RI Addendum are reported as follows:

- The primary source of the contamination plume downgradient of IRP Site No. 6 is the POL Storage Area which provides the fuel for the refueling mission of the

161st ARG. The contamination detected upgradient of the POL Storage Area is the result of an unspecified source at the motor pool. Contamination from the motor pool area is migrating towards the POL Storage Area and merging with the POL plume.

- The contamination plume is fully defined; however, it does vary in areal extent depending upon the local hydrogeological conditions.

- A conceptual model based upon the RI and RI Addendum has been developed. The conceptual model explains the varying concentrations of contamination detected during the groundwater sampling events. There is an inverse relationship between the water table and concentrations of contamination. In summary, as the water levels decline, the concentrations of contamination generally increase.

- Results of microbiologic analyses indicate low levels of microbiological organisms, soil moisture, and nitrate. For bioremediation to be a viable remediation option, it would require microbiologic augmentation. Phosphorus and nitrite-nitrogen levels are sufficient to support microbiologic activity.

- Geotechnical analyses of the soil sample collected from monitoring well 06-023MW at a depth of 39.0 to 40.0 feet BLS was reported as 88.9 percent pebbles and 11.1 percent sand. Sieve analyses of the soil sample collected from monitoring well 06-024MW at a depth of 50.0 to 50.5 feet BLS was reported as 95.3 percent cobble and pebbles, 4.2 percent sand, and 0.5 percent silt and clay. These results indicate both soil samples are a sandy gravel.

- Analyses of soil samples for permeability indicate the soil sample collected from monitoring well 06-023MW at a depth of 39.0 to 40.0 feet BLS was determined to be 9.73×10^{-8} m/sec (9.73×10^{-6} cm/sec) and the permeability of the soil sample collected from monitoring well 06-024MW at a depth of 50.0 to 50.5 feet BLS was determined to be 4.42×10^{-8} m/sec (4.42×10^{-6} cm/sec). According to the USDA, this permeability is very low for a sandy gravel (USDA, 1974). Due to the coarse nature of the substrata it was not possible to collect a complete, undisturbed sample. To compensate, the laboratory substituted a testing method that used an inch cube "plug" for testing. Due to the plug's small size, the size

of the gravels and pebbles in the sleeve, the sample was not representative. Therefore, the reported values are erroneously low.

- Results of the percolation test indicate a high infiltration rate of 448 gal/day/ft^2.

- Twenty-two investigative groundwater samples were submitted for laboratory analysis from the nine newly installed monitoring wells and 13 pre-existing monitoring wells during the July – August 1995 groundwater sampling event. Twenty-two VOCs – benzene, toluene, ethylbenzene, total xylenes, TCE, DCE, PCE, chloroform, carbon tetrachloride, styrene, isopropylbenzene, N-propylbenzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, 1,1 dichloroethane, sec-butylbenzene, P-isopropyltoluene, 1,2,3-trichloropropane, N-butylbenzene, hexachlorobutadiene, chloromethane, and naphthalene – were detected in 21 groundwater samples.

- Benzene was detected in groundwater samples from 17 monitoring wells at concentrations ranging from 0.2 to 4,200 μg/L, exceeding the ADEQ action level of 5 μg/L. Ethylbenzene was detected at concentrations ranging from 0.4 to 750 μg/L, exceeding the ADEQ action level of 700 μg/L in the groundwater sample collected from one monitoring well.

- TCE was detected at concentrations of 0.5 and 7.0 μg/L, exceeding the ADEQ action level of 5 μg/L in the groundwater sample collected from monitoring well 06-016MW. The source of the TCE is unknown; however, the Estes Landfill is located east across the Salt River, and upgradient of the base. The Estes Landfill is a site of known TCE and DCE contamination migrating westward in the general direction of the base.

- TPH were detected at concentrations ranging from 1 to 6 ppm in groundwater samples collected from monitoring wells MWS-04, 06-21MW, 06-022MW, 06-023MW, and 06-024MW. No ADEQ action level exists for TPH in groundwater.

- Results of laboratory analyses on soil and groundwater samples collected during the RI Addendum indicate no new chemicals of concern or any significant changes in chemical concentrations. Geologic data collected during the RI Addendum indicates no new pathways or potential pathways of exposures. The

risk assessment set forth in the RI Report is valid and does not require modification.

General Conclusions based on the RI and this RI Addendum are reported as follows:

- There are two definitive source areas of groundwater contamination at the 161st ARG: the POL Storage Area and the vicinity of the motor pool area. Analytical data supports one plume of fuel-related contaminants migrating from the POL area and a second, smaller plume of fuel-related contaminants migrating from the motor pool area. The motor pool plume merges with the POL plume.

- Reported fuel releases from transfer lines have resulted in groundwater contamination, identified as a plume migrating from the POL area in a west-northwest direction. This plume has a large areal extent and is characterized as containing high concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX).

- Releases from an unspecified source in the motor pool area have also resulted in a groundwater contamination plume migrating in the same direction as the POL plume. Primary constituents of this plume are also characterized as high concentrations of BTEX. Due to its geographical location (upgradient) of the POL Storage Area, this plume is merging into the POL plume.

- There is also an indication of an off-base, upgradient of the 161st ARG, source area most likely originating from across the Salt River. Directly east of the 161st ARG, across the Salt River, is an industrial area. Located in this industrial area is the Estes and Bradley Landfills, the Tanner Company, and the Southbank Lake. At these sites, contamination consisting primarily of the chlorinated solvents TCE, DCE, and benzene have been reported. The assumption as to the source of this contamination is based upon analytical data from the background monitoring wells and hydrogeologic data.

Recommendations based on the conclusions of the RI and RI Addendum are reported as follows:

- There is no consistent monthly water level data at the 161st ARG. The Environmental Office should collect water level data from several wells on a monthly basis.

- The quarterly groundwater sampling program at the 161st ARG should be continued.

- A FS should be completed on IRP Site No. 6 to determine the best remedial alternatives for Remedial Action.

SECTION 1.0 INTRODUCTION

This Addendum to the Remedial Investigation (RI) Report presents the results of investigation activities conducted between 19 June 1995 and 10 August 1995 at Installation Restoration Program (IRP) Site No. 6, the Petroleum, Oils, and Lubricant (POL) Storage Area, 161st Air Refueling Group (ARG), Arizona Air National Guard (AZANG), located at Sky Harbor International Airport, Phoenix, Arizona (Figure 1.1).

Extensive baseline data exists on the 161st ARG from previous IRP environmental investigations. Accordingly, this reports supplements the Remedial Investigation Report for IRP Sites No. 6 and No. 7, 161st Air Refueling Group, Sky Harbor International Airport, Phoenix, Arizona, prepared by Operational Technologies Corporation (OpTech) in August 1995 (hereinafter referred to as the *1995 RI Report*). Information presented in this report is referenced from the Preliminary Assessment, 161st Air Refueling Group, Arizona Air National Guard, Sky Harbor International Airport, Phoenix, Arizona, prepared by Dynamac Corporation for the Hazardous Materials Technical Center in 1988 (hereinafter referred to as the *1988 PA Report*), and the Site Investigation Report, 161st ARG, Arizona Air National Guard, prepared by IT Corporation (IT) in 1992 (hereinafter referred to as the *1992 SI Report*).

To avoid extensive informational redundancy within this report, references to the following sections will be found in the baseline information contained in the aforementioned documents:

- Background Information on the Arizona Air National Guard Base;
- Previous investigations at the site and surrounding areas;
- Background Information on other IRP Sites at the 161st ARG (also referred to as the base); and
- Environmental Setting.

1.1 PURPOSE AND SCOPE OF INVESTIGATION

An RI was conducted at IRP Site No. 6, and IRP Site No. 7, Old Oiled Road, to define the vertical and horizontal extent of contamination within the soil and groundwater. Field activities for the RI commenced on 7 September 1993 and were interrupted on 3 October 1993. Field work resumed on 6 December 1993 and was stopped on 23 December 1993 for the holidays. Field work resumed on 24 January 1994 and was completed on 11 February 1994. Additional groundwater sampling was conducted from 4 to 9 April 1994, 26 to 30 July 1994, and 10 to 13 January 1995. The RI Report was finalized in August 1995.

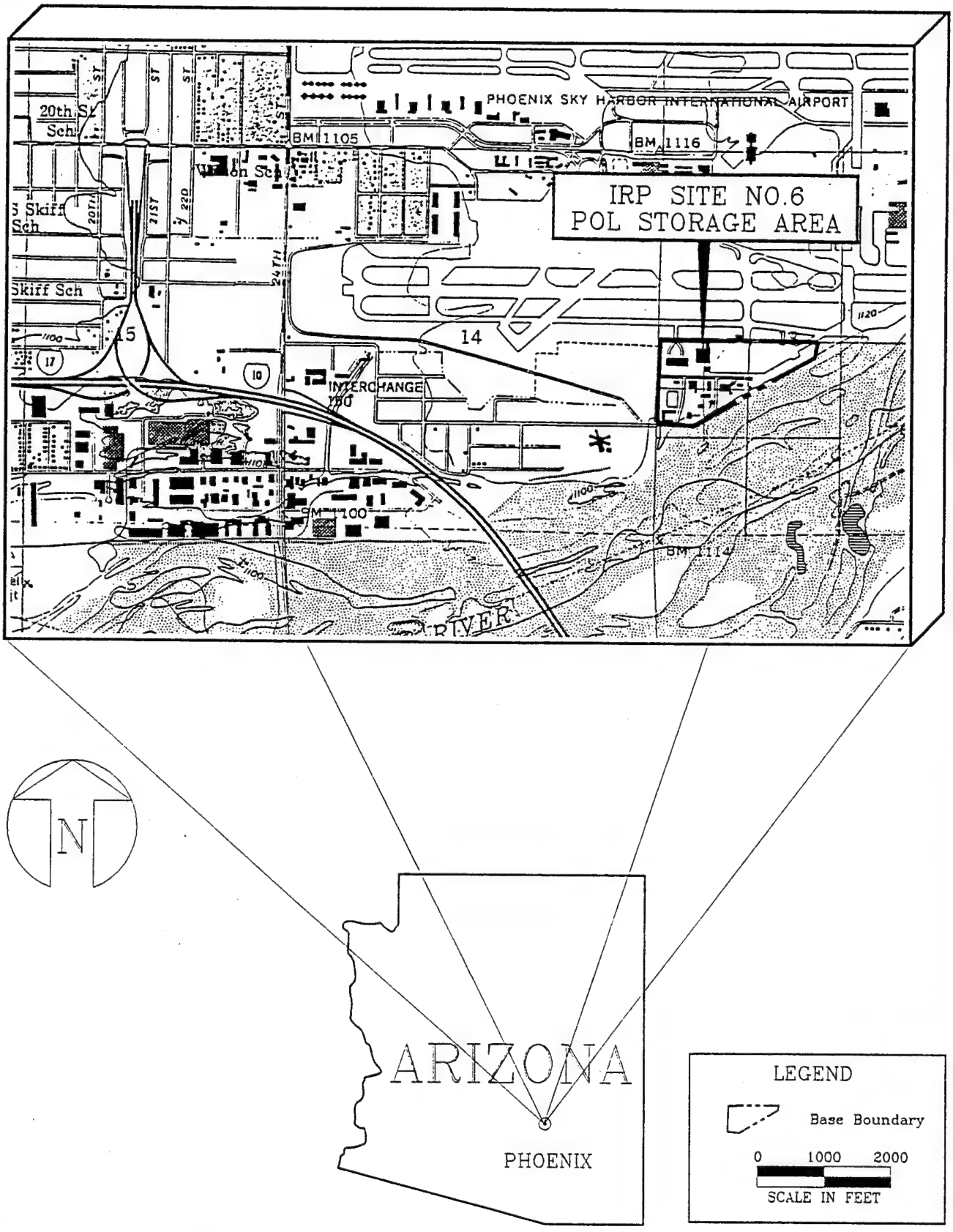


FIGURE 1.1

STATE LOCATION MAP

161st ARG, Arizona Air National Guard
Sky Harbor International Airport
Phoenix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

SKYHARBO\SKY2-116

MARCH 1996

Prior to submitting the Draft-Final RI Report in December 1995, the Air National Guard Readiness Center (ANGRC) (now designated as Headquarters Air National Guard/Installation Restoration Program (HQ ANG/CEVR)) and OpTech determined additional field work was needed to further delineate the plume of contamination migrating from IRP Site No. 6. The investigation at the 161st ARG consisted of the following actions:

- Install two additional monitoring wells to further delineate the plume of contamination migrating off-base from the POL Area;
- Install four additional monitoring wells in the POL Area to further delineate the horizontal extent of contamination near the center of the site;
- Install a monitoring well between and upgradient of monitoring wells MWS-02 and MWS-03 to confirm the presence or absence of contamination migrating on-base from the south;
- Install two monitoring wells, one west of Building 23 and one at the southeast corner of the building, to further delineate contamination detected in monitoring wells 06-001MW, 06-002MW, and 06-010MW;
- Collect soil samples during the drilling of the monitoring well at the southeast corner of Building 23 to determine the presence or absence of contamination near the oil/water separator;
- Conduct two rounds of groundwater sampling from newly installed monitoring wells to coincide with quarterly sampling of existing monitoring wells at the base; and
- Collect soil samples for microbiological and geotechnical analyses.

The results of the study will provide additional technical data needed to support a Feasibility Study (FS) to identify and select the most appropriate Remedial Action for the 161st ARG.

1.2 REPORT ORGANIZATION

This report presents the results of the RI Addendum conducted for IRP Site No. 6 at the 161st ARG and is organized into an Executive Summary, seven sections and nine appendices in four volumes.

The **Executive Summary** summarizes the work that was done, significant findings, and recommendations.

Section 1 **Introduction**, defines the purpose and scope of the investigation, and summarizes the context of this report.

Section 2 **Site Description**, defines the site and the previous investigative history of the site.

Section 3 **Environmental Setting**, defines the regional and local environmental setting including physiography, climate, geology, soil, and hydrology.

Section 4 **Investigation Description**, describes the investigative program conducted at the site. Site-specific field investigations were designed to follow the RI Work Plan Addendum for all phases of field and analytical programs. Details on the field investigation methods used, as well as a description of the analytical and field quality control programs, are provided in this section.

Section 5 **Investigative Findings**, presents the results of the investigative program. The results of geology, hydrogeology, and chemical analyses investigations are presented. These results define the areal extent of the groundwater contamination at the site. The results presented in this section are used to evaluate the future extent of the contamination.

Section 6 Presents **Conclusions and Recommendations** for the site.

Section 7 Contains the **References** cited in the report.

Appendices Contain technical and field data.

1.3 PROGRAM SCHEDULE

The approved RI Work Plan Addendum was submitted to HQ ANG/CEVR in May 1995. Monitoring well installation for the RI Addendum began on 19 June 1995, and was completed on 30 June 1995. Groundwater sampling of the newly installed monitoring wells was conducted from 10 to 14 July 1995. Groundwater sampling coincided with the second round of the quarterly groundwater sampling at the 161st ARG. Due to an error in well sampling procedures for the nine newly installed monitoring wells, the groundwater samples collected were invalid. Therefore, the nine monitoring wells were resampled from 8 to 10 August 1995. The sampling results of all the monitoring wells will be discussed in this report as well as the July 1995

Quarterly Groundwater Sampling Report. The next sampling round of the new monitoring wells coincided with the November 1995 round of quarterly groundwater sampling. Results from that sampling event will be discussed only in the November 1995 Quarterly Groundwater Sampling Report.

1.4 PROJECT TEAM

The OpTech project team consisted of the following key professionals:

The Program Manager, Mr. John Morris, was responsible for the overall execution of this project.

The Project/Site Manager, Mr. Michael A. Giles, directly supervised the project team, provided technical direction and technical interface with HQ ANG/CEVR, directed field operations, and coordinated all OpTech support.

The OpTech Director of Quality Management, Mr. Steve Wilson, was responsible for developing standardized quality assurance procedures for this project, and for assuring that effective procedures and controls were implemented to achieve a high level of quality.

The Health and Safety Manager, Mr. Jon Williams, was responsible for assuring that physical and chemical hazards were appropriately mitigated through effective execution of the Health and Safety Plan. The Health and Safety Officer was Mr. Jeff Blunt, who monitored on-site health and safety during field activities.

Environmental technicians included Mr. Ray Castillo, Senior Environmental Technician, Mr. Chad Frost, Environmental Technician, and Mr. Ross Murray III, Environmental Technician.

The field investigation required the use of subcontractors. Southern Petroleum Environmental Laboratory, Inc. of Houston, Texas, performed the laboratory analyses. Microbiological and geotechnical analyses were provided by Bolin Laboratories of Phoenix, Arizona, and Core Lab Petroleum Services of Carrollton, Texas, respectively. The drilling contractor was North American Drilling of Phoenix, Arizona. The project surveyor was Geotrack, Inc., of Phoenix, Arizona.

1.5 FACILITY BACKGROUND INFORMATION

The 161st ARG is located at the AZANG Base at Sky Harbor International Airport, Phoenix, Arizona. The base occupies approximately 51 acres of land leased from the City of Phoenix along the south side of the Airport (Figure 1.1). The 161st ARG flies and maintains KC-135 aircraft to support its refueling mission under the United States Air Force (USAF) Air Mobility Command. The major support operations performed at the base include aircraft, aerospace ground equipment (AGE), ground vehicle, and facilities maintenance. These operations involve activities such as corrosion control, nondestructive inspection, fuel cell and engine maintenance, hydraulics, and wheel and tire maintenance.

The organizational history of the 161st ARG, historic installation waste disposal practices, and information of previous IRP investigations are included in the *1995 RI Report, 1988 PA Report*, and the *1992 SI Report*.

SECTION 2.0 SITE DESCRIPTION

2.1 LOCATION

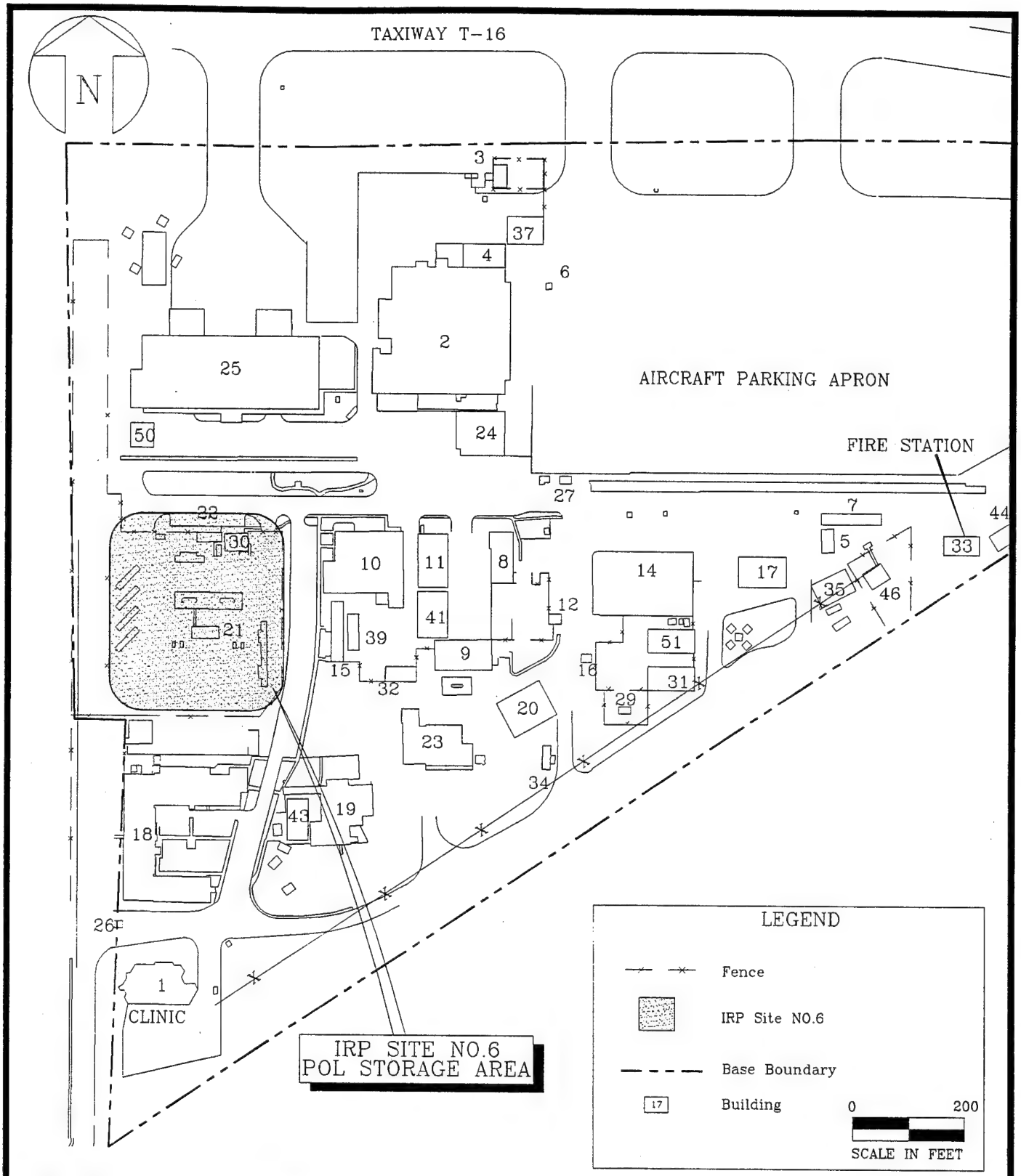
The site is located on the west side of the base, south of Building No. 30 and centered around Building No. 21 (Figure 2.1). The site is the area surrounding and including the POL Storage Area and has been designated as IRP Site No. 6. Located at the site are ten underground storage tanks (USTs), including four 50,000-gallon USTs, four 25,000-gallon USTs, one 7,500-gallon UST, and one 2,000-gallon UST.

The site is a flat, asphalt-and concrete-covered facility that is secured on all sides by a 6-foot high, woven-wire fence, topped with either concertina or barbed wire. Double swinging gates are located in the northwestern and northeastern corners of the facility, with an asphalt driveway for refueling vehicles. Prominent site features include four angled parking pads for refueling trucks along the eastern fenceline, a cinder block administrative building centered along the northern fenceline, a covered parking area for small, wheeled refueling support equipment, a large roof over fuel control assemblies, and a wide variety of aboveground piping connecting USTs to fuel transfer points. Several lighting stanchions provide floodlight coverage of the area.

2.2 SITE HISTORY

The POL Area is the main fuel storage area for the 161st ARG. Because the mission of the 161st ARG is the air-to-air refueling of USAF mission aircraft, the base maintains above average stocks of JP-4, as compared to other Air National Guard facilities. All ten USTs are actively used to support the mission of the 161st ARG.

IRP Site No. 6 was not identified in the *1988 PA Report* for investigation. In 1992, IT conducted a Site Investigation at the 161st ARG. Aromatic hydrocarbons were detected in groundwater samples collected from an upgradient monitoring well for IRP Site No. 3. Monitoring well MWS-04 was installed in the POL Area to determine whether contamination was emanating from the POL area. Nine target compounds, including benzene, toluene, ethylbenzene, and xylenes (BTEX), were detected in the initial round of groundwater samples collected in April 1991. Similar analytical results were obtained for BTEX compounds in the confirmation sampling conducted in June 1991.



SOURCE: MODIFIED FROM 161ST ARG CIVIL ENGINEERING.

FIGURE 2.1

SKYHARBO\SKI1-2IR

LOCATION OF IRP SITE NO.6 PETROLEUM, OIL, AND LUBRICANT STORAGE AREA
161st ARG, Arizona Air National Guard
Sky Harbor International Airport
Phoenix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

APRIL 1996

Piezometer PS-02 was installed south of the POL area as part of a three-piezometer network to determine geologic conditions and direction of groundwater flow prior to installation of background and downgradient monitoring wells at the base. PS-02 was sampled and analyzed in April and June 1991, due to the presence of benzene and other compounds detected during field screening. Seven target compounds – BTEX, 1,2-dichloroethane (DCA), 1,2-dichloro-ethylene (DCE), and trichloroethylene (TCE) – were detected during the April 1991 initial sampling event. Only BTEX was detected during the June 1991 sampling event. Based upon this information, the POL Storage Area was added to the IRP investigation as Site No. 6. Details of the investigation can be found in the *1992 SI Report*.

From September 1993 to July 1994, OpTech conducted an RI at IRP Sites No. 6 and No. 7. The field investigation at IRP Site No. 6 was accomplished by collecting 40 soil vapor samples; drilling 15 soil borings; collecting 45 soil samples for analysis of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and total petroleum hydrocarbons (TPH); installing 17 groundwater monitoring wells; and collecting four rounds of groundwater samples for analysis of VOCs, SVOCs, and TPH.

BTEX and TPH were detected in soil samples collected at depths ranging from 43.5 to 51.0 feet below land surface (BLS). Isolated pockets of TPH were also detected in near-surface soil samples. Only benzene, total xylenes, and TPH were detected at concentrations exceeding the Arizona Department of Environmental Quality (ADEQ) action levels.

A groundwater plume of contamination was delineated migrating 2,100 feet downgradient (to the northwest) and off the base onto Sky Harbor International Airport property. Groundwater contamination was also detected upgradient of the POL Storage Area near the base motor pool area. Only benzene, ethylbenzene, and 1,1,1-trichloroethane (TCA) were detected in groundwater at concentrations exceeding ADEQ action levels.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 3.0 ENVIRONMENTAL SETTING

The environmental setting of the 161st ARG is presented though discussions of physiography, climate, geology, soils, hydrogeology, and surface water. More detailed descriptions of each and regional background data applicable to the 161st ARG are presented in the *1992 SI Report* and the *1995 RI Report*.

3.1 PHYSIOGRAPHY

The City of Phoenix lies within the Salt River Valley of the Sonoran Desert section of the Basin and Range physiographic province. The Basin and Range is characterized by fault block and volcanic mountain ranges separated by relatively flat alluvial valleys. Phoenix is located on an alluvial valley at an elevation of approximately 1,100 feet above mean sea level (MSL). South of Phoenix, approximately six miles from the base, the South Mountains rise to an elevation of 2,500 feet above MSL. Eighteen miles southwest of the base, the Estrella Mountains rise to 4,500 feet above MSL; 30 miles to the west, the White Tank Mountains rise to 4,000 feet above MSL; and the Superstition Mountains rise to 5,000 feet above MSL approximately 30 miles to the east. The Hieroglyphic Mountains border the valley on the north at an elevation of 3,370 feet above MSL, and the Camelback Mountains border on the east and northeast, rising to 2,700 feet above MSL.

The 161st ARG is located at the Phoenix Sky Harbor International Airport in Maricopa County, on relatively flat terrain with surface elevations ranging from 1,110 feet above MSL along the southern boundary, to near 1,120 feet above MSL in the northeast. South of the base, an escarpment forms the edge of the Salt River Valley.

3.2 CLIMATE

The climate of Phoenix is characterized by warm arid conditions. Temperatures range from very hot in summer, typically higher than 100 degrees Fahrenheit (°F) from early May through early September. Temperatures are mild in winter months, averaging 66° F in December and January. Average annual precipitation is 7.11 inches, occurring primarily in two seasons: from late November to early April, associated with Pacific storms; and during July and August, as convective thunderstorms. Winds are generally easterly and light, with a mean velocity of 6.3 miles per hour (mph).

3.3 GEOLOGY

Deep basins with up to 10,000 feet of sedimentary and volcanic fill are located within the Basin and Range physiographic province. Geologic deposits are divided into six primary units: metamorphic and granitic rocks; extrusive rocks; red unit; and upper, middle, and lower units of basin fill.

The base is located north of and adjacent to the Salt River and is underlain primarily by coarse channel deposits of sand, gravel, cobbles, and boulders of Holocene age. The deposits are unconsolidated and form part of the upper alluvial unit basin fill deposits. These deposits are heterogeneous both horizontally and vertically, and are characteristic of a high-energy fluvial system.

3.4 SOILS

Soils at the base consist primarily of the Carrizo fine sandy loam and the Gilman loam. Soils along the south perimeter of the base, adjacent to the Salt River, are considered alluvial land.

3.5 HYDROLOGY

3.5.1 Hydrogeology

Crystalline rocks surrounding Phoenix are effectively impermeable, forming hydrologic borders to the basin. Groundwater occurs in sedimentary deposits of the Salt River Valley area under leaky confined to unconfined aquifer conditions.

Groundwater recharge in the area is derived from infiltration of precipitation, runoff from surrounding mountains, and controlled releases from upstream reservoirs on major rivers. Groundwater flow in the Phoenix area is generally from the northeast, flowing westerly under the Salt River toward pumping centers in the basin. Municipal water supplies in the Phoenix area and for the base are derived primarily from surface-water reservoirs and from groundwater in basin fill alluvium.

Groundwater may occur locally at a depth of approximately 45 feet BLS under unconfined conditions but may be as deep as 70 to 80 feet BLS. The groundwater flow direction, consistent with the regional setting, is westerly to northwesterly. The groundwater underlying the base is not presently used for drinking water purposes.

3.5.2 Surface Water

The Salt River is the primary surface drainage system of the area sloping west through Phoenix to a confluence with the Gila River. The Salt River is generally dry and flow occurs during prolonged periods of intense precipitation or during releases from upstream reservoirs. Airport drainage flows overland and through storm drains to outfalls in the river. Three water supply and drainage canals pass near the base. The Grand Canal passes approximately 1.5 miles north of the base; the San Francisco Canal-North Branch passes approximately 0.75 miles south of the base and the Salt River; and the Hayden Canal passes within 1.5 miles east of the base.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 4.0 FIELD PROGRAM

The purpose of this RI Addendum was to further delineate the extent of groundwater contamination at the 161st ARG. The field investigation was performed in three phases. The first phase was conducted from 19 to 30 June 1995 and consisted of drilling and installing nine monitoring wells, drilling one soil boring, collecting composite soil samples from drill cuttings, collecting soil samples for microbiological and geotechnical analyses, and conducting a percolation test. The second phase was conducted from 10 to 14 July 1995 and consisted of collecting groundwater samples from 22 monitoring wells. However, the nine newly installed monitoring wells were improperly sampled, and, as a result, were resampled during the third phase from 10 to 13 August 1995.

4.1 GENERAL INVESTIGATION APPROACH

This section provides a brief description of the investigation for the RI Addendum at IRP Site No. 6. The field investigation was comprised of:

- Drilling and installing nine monitoring wells,
- Drilling one soil boring,
- Performing lithologic descriptions,
- Collecting ten composite samples from drill cuttings for disposal criteria
- Collecting two soil samples for microbiological analyses and two soil samples for geotechnical analyses,
- Conducting one percolation test,
- Measuring and recording water-levels and groundwater parameters,
- Collecting 22 groundwater samples, and
- Surveying the soil boring and monitoring well locations.

The 22 groundwater samples were collected from the nine monitoring wells installed during this field effort and 13 monitoring wells installed during previous field programs and sampled as part of a quarterly groundwater sampling program.

Nine groundwater monitoring wells were installed at IRP Site No. 6 during the RI Addendum:

- Two monitoring wells, 06-018MW and 06-019MW, were drilled and installed to further delineate the plume of contamination migrating off-base from the POL Area;

- Monitoring well 06-020MW was drilled and installed between and upgradient of monitoring wells MWS-02 and MWS-03 to confirm the presence or absence of contamination migrating on-base from the south;

- Four monitoring wells 06-021MW, 06-022MW, 06-023MW, and 06-024MW, were drilled and installed west, north, and east of the POL Area to further delineate the horizontal extent of contamination near the center of the Site;

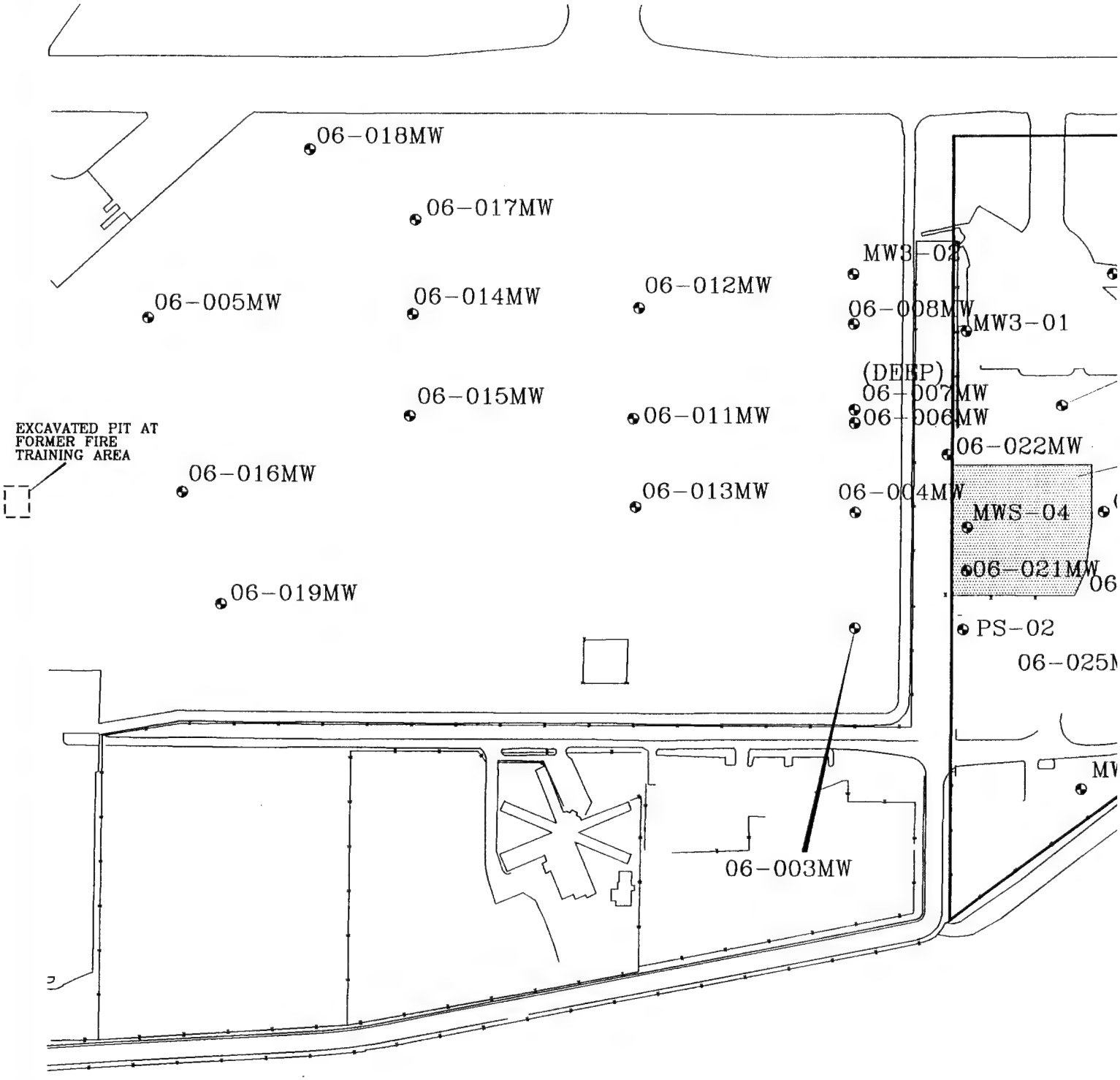
- Monitoring well 06-025MW was drilled and installed west of Building 23 to further delineate the contamination detected in monitoring wells 06-001MW, 06-002MW, and 06-010MW; and

- Monitoring well 06-026MW was drilled and installed at the southeast corner of Building 23 to help determine if the oil/water separator at that location is a possible source of the contamination detected in monitoring wells 06-001MW, 06-002MW, and 06-010MW.

The location of all monitoring wells at the 161st ARG are shown on Figure 4.1.

One soil boring, 06-016BH, was drilled in the POL area to collect soil samples for analysis of microbiological activities in an area of known contamination. The boring was drilled near boring 06-013BH which had the highest levels of benzene and total xylenes detected at the POL storage area during the RI. The soil boring was abandoned with cement/bentonite grout when completed. The locations of soil borings 06-013BH and 06-016BH are shown on Figure 4.2.

Additional soil samples were collected from monitoring wells 06-023MW and 06-024MW for geotechnical analyses of permeability and grain size. Soil samples were collected using a 3-inch diameter split-spoon sampler equipped with brass sleeves. An attempt to collect soil samples for analyses of VOCs and TPH in monitoring well 06-026MW, located at the southeast corner of Building 23 near the oil/water separator, was unsuccessful due to extremely poor recoveries.

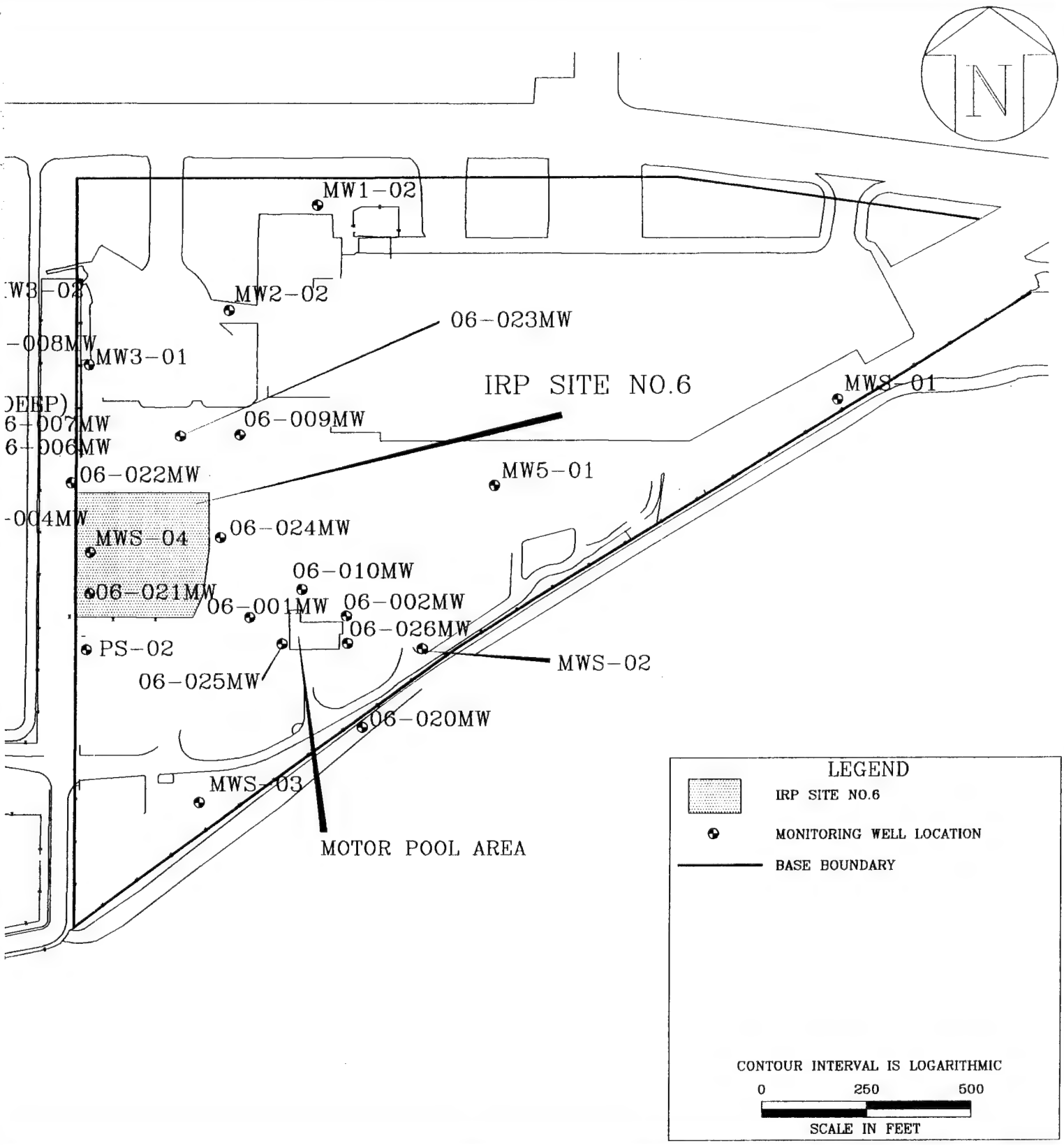


SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 4.1

SKYHARBO\1315-227\MON-3

MONITORING WELL L
ON 10-14 JULY
161st ARG, Arizona Air N
Sky Harbor Internatio
Phoenix, Ariz



RING WELL LOCATIONS
10-14 JULY 1995

Arizona Air National Guard
rbor International Airport
Phoenix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

MARCH 1996

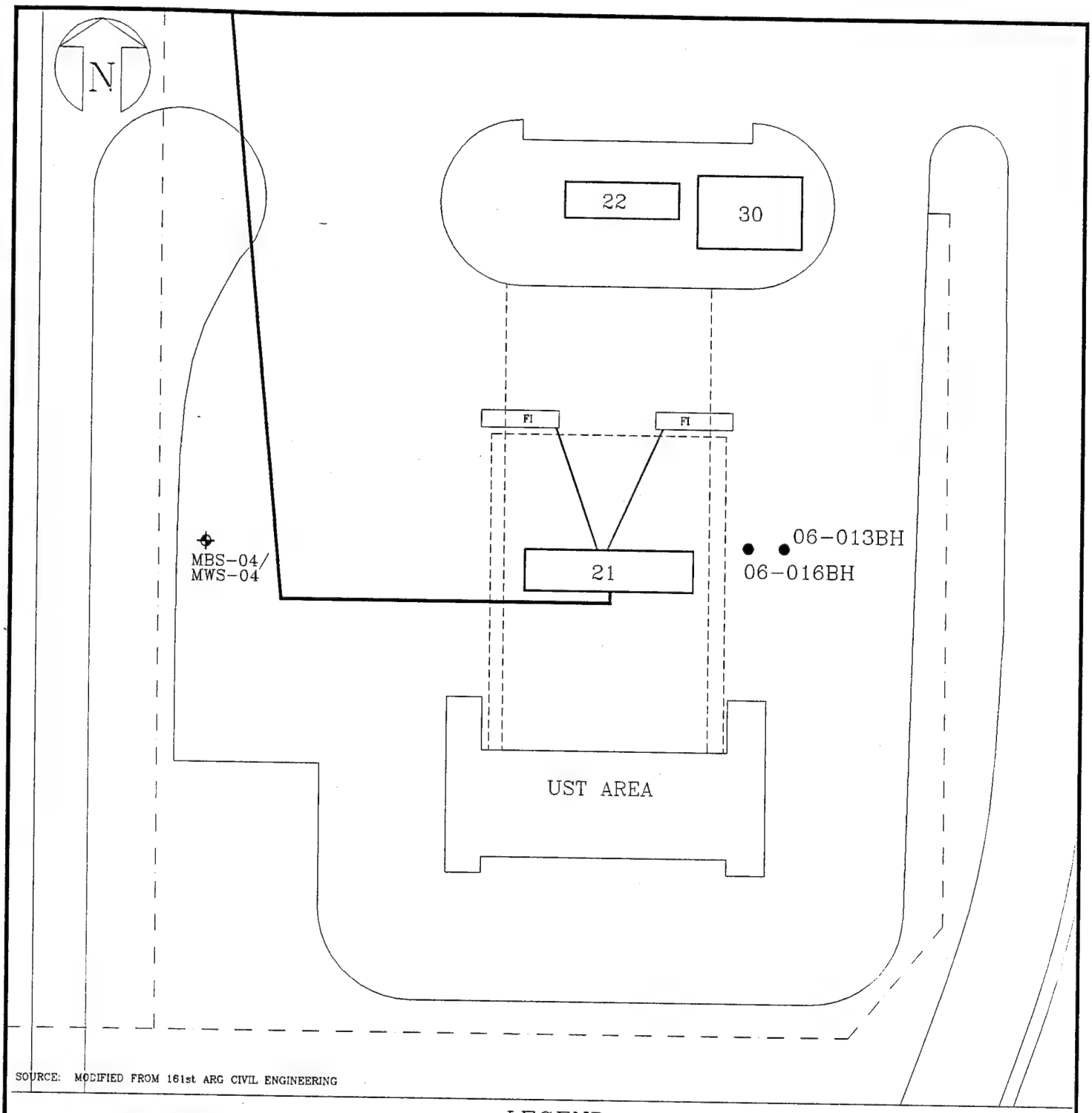


FIGURE 4.2

SKYHARBO\CONTOUR

LOCATIONS OF SOIL BORINGS 06-013BH AND 06-016BH AT IRP SITE NO.6
161st ARG, Arizona Air National Guard
Sky Harbor International Airport
Phoenix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

MARCH 1996

4.2 DEVIATIONS FROM THE WORK PLAN

There were three deviations from the Work Plan. The deviations from the Work Plan and the rationale for the changes are described as follows:

- Attempts were made to collect soil samples during the drilling of the monitoring well at the southeast corner of Building 23 to determine the presence or absence of contamination near the oil/water separator. Due to auger refusal, sufficient soil sample could not be recovered.

- The sample jar containing the composite soil sample collected from boring 06-016BH was broken during shipment to the laboratory. A second composite was collected from the drummed soil cuttings during the July 1995 sampling event. The chain-of-custody was incorrectly labeled, and, as a result, the soil sample was not analyzed for VOCs. Disposal criteria for soil cuttings from boring 06-016BH are based upon the analytical results from boring 06-013BH, located 5 feet from boring 06-016BH (OpTech, 1995).

- Groundwater samples collected from monitoring wells 06-018MW through 06-026MW during the July 1995 sampling event were determined to be invalid due to an error in sampling procedures. The wells were developed/purged but were not purged again prior to sampling 24 to 48 hours later. The wells were resampled in August 1995.

4.3 SCREENING ACTIVITIES

Soil samples were not collected for chemical analyses; therefore, there was no field screening with a photoionization detector (PID) nor field gas chromatograph. A PID was used to monitor the breathing zone for health and safety criteria.

4.4 CONFIRMATION ACTIVITIES

4.4.1 Geologic Investigation

The geologic investigation consisted of lithologic descriptions of all nine monitoring wells and the soil boring. The monitoring wells and soil boring are listed in Table 4.1. The locations of the monitoring wells and the soil boring are presented in Figures 4.1 and 4.2, respectively.

The lithologic descriptions are based on visual observation of drill cuttings. The AP-1000 percussion drilling method uses high-pressure air to remove drill cuttings from the dual-wall pipe and "blows" the cuttings into drums. As a result, the on-site geologist was able to describe general lithology at known depths. The lithologic descriptions for each borehole were recorded in a field logbook and are noted on boring logs included as Appendix A, Boring Logs. The monitoring well construction logs are included in Appendix B, Well Construction Logs. A copy of the field notes is presented in Appendix I, Field Documentation.

Table 4.1
Investigation Summary for IRP Site No. 6
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Monitoring Wells and Soil Boring	Approximate Drill Depth (feet BLS)	Sample Type and Number of Samples
06-016BH	55	SS,2[A]
06-018MW	90	GW,2*
06-019MW	90	GW,2*
06-020MW	90	GW,2*
06-021MW	90	GW,2*
06-022MW	90	GW,2*
06-023MW	90	SS,1[B];GW,2*
06-024MW	90	SS,1[B];GW,2*
06-025MW	90	GW,2*
06-026MW	90	GW,2*

BLS – Below Land Surface.
SS – Soil Samples.
BH – Borehole.
A – Microbiological Analyses.
MW – Monitoring Well.
B – Geotechnical Analyses.
GW – Groundwater Sample.
* – Second round of groundwater sampling planned for November 1995.

4.4.2 Soil Investigation

The soil investigation consisted of collecting soil samples for microbiological and geotechnical analyses. Soil samples were collected with an 18-inch long carbon-steel California-style, split-spoon sampler, equipped with three 6-inch long, 3-inch diameter brass sleeves. A summary of the kind and number of analyses performed on the soil samples is given in Table 4.2.

Table 4.2
Analyses Performed on IRP Site No. 6 Soil Samples
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Location Number	Sample Depth Feet BLS	Soil Analyses	
		Microbiological	Geotechnical
06-016BH	46.0 - 47.5 50.0 - 51.0	X X	
06-023MW	1.5 - 2.0		X
06-024MW	1.5 - 2.0		X

BLS – Below Land Surface. BH – Borehole. MW – Monitoring Well.

4.4.2.1 Microbiological Investigation

Two samples were collected for microbiological analyses and analyzed for total heterotrophs (Standard Method (SM) 9215), total hydrocarbon degraders, pH (SW 9040), moisture (SM 2540), nitrate- and nitrite-nitrogen (USEPA Method 353.3), and phosphorous (USEPA Method 365.2). Samples were collected from soil boring 06-016BH at depths of 46.0 to 47.5 feet BLS and 50.0 to 51.0 feet BLS. Boring 06-016BH was drilled within five feet of boring 06-013BH. The highest levels of benzene and total xylenes detected during the RI were from 06-013BH at depths ranging from 43.5 to 51.0 feet BLS. Results of the microbiological analyses are presented in Appendix C, Results of Microbiological Studies. A discussion of the analytical results is presented in Subsection 5.2.3.1.

4.4.2.2 Geotechnical Investigation

Two samples collected for geotechnical analyses were analyzed for permeability and grain-size using American Society of Testing and Materials (ASTM) Methods D5084 and D422, respectively. Results of the geotechnical analyses are presented in Appendix D, Results of Geotechnical and Percolation Studies. A discussion of the analytical results is presented in Subsection 5.2.3.2.

4.4.2.3 Percolation Test

A percolation test was completed to determine preliminary hydrogeologic data in the vadose zone needed for evaluating discharge options of treated water. The test was performed at monitoring well 06-023MW at a depth of 39 feet BLS. The 9-inch inside diameter (ID) drill pipe was filled with water until saturated conditions were obtained in the geologic stratum at the base of the drill

pipe. The water was obtained from the base water supply. The drill pipe was filled with water and the subsequent decline in water level measured and recorded with a transducer and data logger for seven hours. According to the ADEQ, due to the short duration of the test and the small amount of potable water used, ADEQ rules and laws governing reinjection of groundwater do not apply (Trosi, 1995). Results of the percolation test are included in Appendix D, Results of Geotechnical and Percolation Studies. A discussion of the analytical results is presented in Subsection 5.2.3.3.

4.4.2.4 Contamination Investigation

Attempts to collect soil samples from monitoring well 06-026MW for laboratory analyses of VOCs and TPH were unsuccessful due to poor recoveries. Monitoring well 06-026MW was drilled next to the oil/water separator at the southeast corner of Building 23. Samples were to be analyzed to determine if the oil/water separator is a source of contamination upgradient of the POL area.

4.4.3 Groundwater Investigation

The groundwater investigation consisted of measuring and recording groundwater parameters, surveying all water level measuring points and locations, and laboratory analyses of groundwater samples. The groundwater investigation of the monitoring wells installed during the RI Addendum coincided with the quarterly sampling of 13 selected monitoring wells. These 22 monitoring wells were sampled again in December 1995, as part of the quarterly sampling program.

4.4.3.1 Aquifer Investigation

Water-level, pH, temperature, and specific conductance measurements were taken prior to the sampling of the monitoring wells. Results are presented in Subsection 5.2.2.

4.4.3.2 Groundwater Sampling Investigation

Based on the requirements of the ADEQ, groundwater samples were analyzed for VOCs and TPH using USEPA Methods 502.2 and 418.1, respectively. A total of 22 groundwater and 20 quality assurance/quality control (QA/QC) samples were analyzed for VOCs and TPH. A summary of the kinds and numbers of analyses performed on the groundwater samples for each monitoring well location is given in Table 4.3. The laboratory analyses are summarized in

Table 4.3
Chemical Analyses Performed on
Groundwater Samples Collected at IRP Site No. 6
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Monitoring Well	QA/QC	VOCs (502.2)	TPH (418.1)
MWS-01		X	X
MWS-02		X	X
MWS-03		X	X
MWS-04	 Duplicate	X X	X X
MW3-02		X	X
MW5-01	 Duplicate	X X	X X
06-003MW		X	X
06-005MW	 Duplicate	X X	X X
06-012MW		X	X
06-013MW		X	X
06-015MW		X	X
06-016MW		X	X
06-017MW		X	X
06-018MW		X	X
06-019MW		X	X
06-020MW		X	X
06-021MW		X	X
06-022MW		X	X
06-023MW		X	X
06-024MW	 Duplicate	X X	X X
06-025MW		X	X
06-026MW		X	X
	Equipment Rinsate Blank (3)	X	X
	Field Blanks (3)	X	X
	Trip Blank (10)	X	

MW/MWS – Monitoring Well.
VOCs – Volatile Organic Compounds.
QA/QC – Quality Assurance/Quality Control.
TPH – Total Petroleum Hydrocarbons.

Table 4.4. Analytical results for the analyses are presented in Appendix E, Analytical Results of Groundwater and Composite Soil Samples. A discussion of the analytical results is presented in Subsection 5.2.4.

VOC samples were stored in two 40-milliliter (mL) glass vials with Teflon™-lined lids, and preserved with a solution of 1:1 hydrochloric acid to achieve a pH of less than 2. TPH samples were stored in 1-liter amber glass bottles with Teflon™-lined lids, and preserved with a solution of 1:1 sulfuric acid to achieve a pH of less than 2.

4.4.4 Quality Control of Field Sampling

Field duplicate samples, field blanks, equipment blanks, and trip blanks were submitted to the analytical laboratory for assessment of the quality of data resulting from the field sampling program. Field, trip, and equipment blank samples were analyzed to check for procedural contamination and ambient conditions at the site that may have caused sample contamination.

Duplicate samples were submitted to provide a quality assurance check on analytical procedures and results.

The level of the quality control effort included approximately one equipment blank, one field blank, and one field duplicate for every 10 or fewer investigative samples per matrix. One VOC analysis trip blank, consisting of distilled, de-ionized, ultra-pure water, was included along with each shipment of samples. One matrix spike/matrix spike duplicate was collected for every 20 or fewer investigative soil samples. Matrix samples provide information about the effect of the sample matrix on the analytical methodology. Analytical results for the analyses are discussed and presented in Appendix E, Analytical Results of Quality Assurance/Quality Control Samples.

The quality control level of effort for the field measurement of pH consisted of a pre-measurement calibration and a post-measurement verification using two standard reference solutions each time. This procedure was performed at least once per day or more often as necessary. Quality control effort for field conductivity measurements included a daily calibration of the instrument using standard solutions of known conductivity.

4.4.5 Investigation Derived Waste

During the RI Addendum, a certain amount of waste material (personal protective equipment (PPE), drill cuttings, purge water, and miscellaneous derived wastes) were produced as a result

Table 4.4
Laboratory Analyses Summary Table
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Site No.	Matrix	Field Parameters	Lab Parameters & Test Methods	Investigation Samples	Number of Field QA/QC Samples					Matrix Totals
					Trip Blanks	Equipment Blanks	Field Blanks	Field Duplicate	MS/ MSD	
6	Soil (Subsurface)	Soil Classification	VOCs/8240	9[a]	3*	1*	1	1	1	12
			TPH/ADHS BLS181	10[a]		1*	1	1	1	13
	Water (Subsurface)	Temperature, pH, Specific Conductance	VOCs/502.2	22	10*	3*	3	4		29
			TPH/418.1	22		3*	3	4		29

* – Trip and Equipment Blanks are not counted in Matrix Totals.
QA/QC – Quality Control/Quality Assurance.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.

ADHS BLS181 – Arizona Department of Health Services method of analysis for TPH.
[a]Samples composited from soil cuttings to determine disposal criteria.

VOCs – Volatile Organic Compounds.
TPH – Total Petroleum Hydrocarbons.
PID – Photoionization Detector.

of investigative activities. Drill cuttings were produced during the installation of monitoring wells and the soil boring. All soil cuttings from each drilling location were drummed separately in steel 55-gallon drums at the time of drilling. Composite soil samples of soil cuttings were collected from each monitoring well and the one soil boring to determine disposal criteria of the cuttings. These composite samples were analyzed for VOCs and TPH using USEPA Method 8240 for VOCs and Arizona Department of Health Services (ADHS) Method BLS-181 for TPH. Composite samples were collected in 8-ounce, wide-mouth jars during drilling. A summary of the kinds and numbers of analyses preformed on soil cutting composite samples for each monitoring well location is given in Table 4.5.

Table 4.5
Chemical Analyses Performed on Soil Cuttings Collected at IRP Site No. 6
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Soil Boring or Monitoring Wells	QA/QC	Soil Analyses		QA/QC Analyses (Liquid Medium Only)	
		VOCs 8240	TPH BLS-181	VOCs 8240	TPH 418.1
06-016BH		X	X		
06-018MW		X	X		
06-019MW		X	X		
06-020MW		X	X		
06-021MW		X	X		
06-022MW		X	X		
06-023MW		X	X		
06-024MW		X	X		
06-025MW		X	X		
06-026MW		X	X		
	Duplicate	X	X		
	MS/MSD	X	X		
	Equipment Rinsate Blank (1)			X	X
	Field Blanks (1)			X	X
	Trip Blank (3)			X	

BH – Borehole.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.
MW – Monitoring Well.
VOCs – Volatile Organic Compounds.
QA/QC – Quality Assurance/Quality Control.
TPH – Total Petroleum Hydrocarbons.

Well development and purge water from each well location was also drummed separately.

Since no PID readings of soil cuttings were over 100 ppm, miscellaneous derived wastes (e.g., gloves, Visqueen™ sheeting, and wipes) which came in contact with drill cuttings were disposed in base waste containers.

All drums were properly marked to indicate their contents, the collection data, contractor's name and phone number, and borehole/monitoring well identification number.

4.4.5.1 Drums Containing Soil Cuttings

Seventy-nine drums containing drill cuttings were accumulated during the RI. Guidance for the final disposition of drummed materials is provided in Appendix F.

4.4.5.2 Drums Containing Non-Potable Water

Sixty-two drums containing development and purge water were accumulated during the RI. Development and purge water from each well location was drummed separately. All drums were properly marked to indicate their contents, the collection date, contractor's name and phone number, and monitoring well identification number. Appendix F lists the well locations for which drums containing development and purge water, the recommended disposition of those drums, and the rationale for each recommendation.

4.4.5.3 Drums Containing Asphalt

Seven drums containing asphalt were accumulated during the RI. These drums can be disposed of at a licensed landfill.

SECTION 5.0 INVESTIGATIVE FINDINGS

5.1 SUMMARY

This section includes the geology and hydrogeology of IRP Site No. 6 and the results of the microbiological and geotechnical analyses of soil samples and chemical analyses of groundwater samples. Only analytes that were detected in groundwater are addressed in this section. The analytical results for each sample, analytical method, method detection limit are provided in Appendix E, Analytical Results of Groundwater and Composite Soil Samples.

The words *contaminant* and *contamination* are used throughout the text of this section. Contamination, in the context of this report, is defined as the presence of any substance introduced into the environment as a result of man's activities without regard to whether the concentrations have reached levels that may cause a significant level of water quality degradation and does not imply a risk to human health. A contaminant is the substance causing the contamination.

The suspected source of the contamination downgradient of IRP Site No. 6 is the petroleum storage and pumping system which provided the fuel for the refueling mission of the 161st ARG. The upgradient contamination is the result of an unknown source in or around the motor pool.

5.2 IRP SITE NO. 6, POL STORAGE AREA

5.2.1 Site Geologic Findings

Lithologic descriptions were obtained by visually observing cuttings "blown" into the drums by the AP-1000 dual walled percussion drilling rig. These lithologic descriptions were used to provide additional geological information. Lithologic logs for boreholes drilled during the RI Addendum are presented in Appendix A, Boring Logs.

Descriptions of the subsurface geology beneath the 161st ARG is presented in the *1995 RI Report* (OpTech, 1995). The lithologic descriptions recorded during the RI Addendum support the geologic interpretation reported in the *1995 RI Report*. The predominant lithology encountered in soil borings and monitoring wells at the 161st ARG consisted of sandy gravels and gravelly sands, with occasional layers of clayey and silty sands, well-sorted sands, and sandy silts. These gravelly sands and sandy gravels are heterogeneous both horizontally and vertically. Clayey and silty layers are isolated and of limited areal and horizontal extent.

5.2.2 Site Hydrogeologic Findings

Temperature, pH, and specific conductance were measured during groundwater sampling and are presented in Table 5.1. Temperature ranged from 76.5 °F to 84.1 °F. The pH varied from 7.02 to 8.79. Specific conductance ranged from 630 to 1,397 millimhos (mhos).

Water-level measurements were measured and recorded for all 22 monitoring wells sampled from 11 to 14 July 1995, and for the nine monitoring wells resampled from 10 to 13 August 1995. These measurements are presented in Table 5.2. In addition, six partial or complete water level measurements were taken between September 1993 and January 1995. All water level measurement data are presented in Appendix G, Table G.1. The water-level altitudes from the 11 to 14 July 1995 sampling event were used to interpret the potentiometric maps presented as Figure 5.1. The potentiometric maps for the January 1995 and July 1994 groundwater sampling events are included for comparison in Figures 5.2 and 5.3, respectively. For all sampling events, the direction of groundwater movement appears to be toward the west-northwest as interpreted in the *1995 RI Report* (OpTech, 1995).

Table 5.1
Temperature, pH, and Specific Conductance Measurements for Groundwater Samples at IRP Site No. 6
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Monitoring Well Number	Date	Temperature (° F)	pH	Specific Conductance (mhos)
MWS-01	7/13/95	82.2	7.95	630
MWS-02	7/13/95	82.5	7.44	870
MWS-03	7/14/95	82.7	7.47	877
MWS-04	7/14/95	76.5	7.45	1,242
MW3-02	7/14/95	83.1	7.63	1,075
MW5-01	7/14/95	82.3	7.81	819
06-003MW	7/14/95	83.6	7.87	839
06-005MW	7/13/95	79.7	7.25	760
06-012MW	7/14/95	81.4	7.80	817
06-013MW	7/14/95	82.2	7.80	1,071
06-015MW	7/14/95	84.1	7.67	915
06-016MW	7/13/95	80.9	7.02	699

Table 5.1 (Concluded)
Temperature, pH, and Specific Conductance Measurements for Groundwater Samples at IRP Site No. 6 161st ARG, Arizona Air National Guard, Phoenix, Arizona

Monitoring Well Number	Date	Temperature (° F)	pH	Specific Conductance (mhos)
06-017MW	7/13/95	81.1	7.26	935
06-018MW	8/9/95	82.1	7.95	703
06-019MW	8/9/95	81.3	8.28	671
06-020MW	8/10/95	79.1	7.99	732
06-021MW	8/9/95	80.9	7.87	867
06-022MW	8/8/95	81.2	7.98	1,397
06-023MW	8/8/95	81.0	7.89	1,072
06-024MW	8/10/95	80.5	7.7	885
06-025MW	8/8/95	82.7	8.03	895
06-026MW	8/9/95	81.4	8.79	698

MWS and MW – Monitoring Well. mhos – millimhos.
°F – Degrees Fahrenheit.

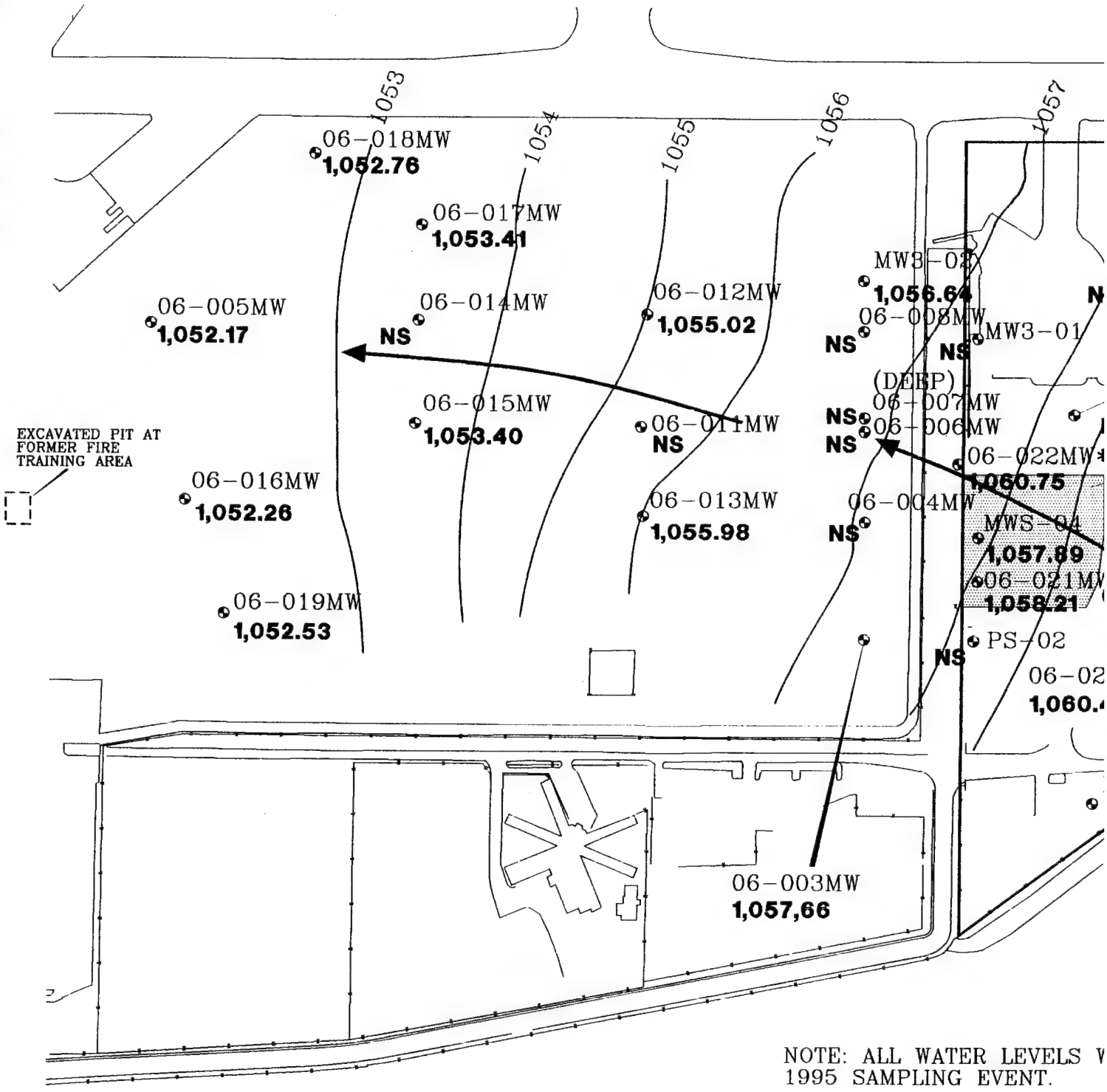
Table 5.2
Groundwater Level Measurement Data at IRP Site No. 6 161st ARG, Arizona Air National Guard, Phoenix, Arizona

Well Number and Elevation of TOC (feet above MSL)	Measurement Date	Depth to Water from TOC (feet)	Groundwater Elevation (feet above MSL)
MWS-01 1,118.4	7/13/95	57.29	1,061.11
MWS-02 1,115.61	7/13/95	55.37	1,060.24
MWS-03 1,115.84	7/14/95	55.98	1,059.86
MWS-04 1,114.67	7/14/95	56.68	1,057.99
MW3-02 1,112.14	7/14/95	55.50	1,056.64
MW5-01 1,116.80	7/14/95	57.12	1,059.68

Table 5.2 (Concluded)
Groundwater Level Measurement Data at IRP Site No. 6
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Well Number and Elevation of TOC (feet above MSL)	Measurement Date	Depth to Water from TOC (feet)	Groundwater Elevation (feet above MSL)
06-003MW 1,116.91	7/14/95	59.25	1,057.66
06-005MW 1,108.46	7/13/95	56.29	1,052.17
06-012MW 1,113.87	7/14/95	58.85	1,055.02
06-013MW 1,113.85	7/13/95	57.87	1,055.98
06-015MW 1,113.46	7/14/95	60.06	1,053.40
06-016MW 1,111.86	7/13/95	59.60	1,052.26
06-017MW 1,111.86	7/13/95	58.45	1,053.41
06-018MW 1,108.78	7/13/95 8/9/95	56.02 57.58	1,052.76 1,051.20
06-019MW 1,111.94	7/13/95 8/9/95	59.41 61.09	1,052.53 1,050.85
06-020MW 1,116.57	7/13/95 8/10/95	55.5 57.79	1,061.07 1,058.78
06-021MW 1,114.31	7/13/95 8/8/95	56.1 58.02	1,058.21 1,056.29
06-022MW 1,114.21	7/13/95 8/8/95	54.06 56.15	1,060.15 1,058.06
06-023MW 1,114.42	7/13/95 8/8/95	55.73 57.83	1,058.69 1,056.57
06-024MW 1,115.12	7/13/95 8/10/95	55.39 57.74	1,059.73 1,057.38
06-025MW 1,115.56	7/13/95 8/8/95	55.07 57.09	1,060.49 1,058.47
06-026MW 1,115.55	7/13/95 8/9/95	55.5 57.27	1,060.05 1,058.28

TOC – Top of casing.
MSL – Mean sea level.
MW and MWS – Monitoring Well.



NOTE: ALL WATER LEVELS W
1995 SAMPLING EVENT.

*NOTE: POTENTIOMETRIC VA
AND DISREGARDED.

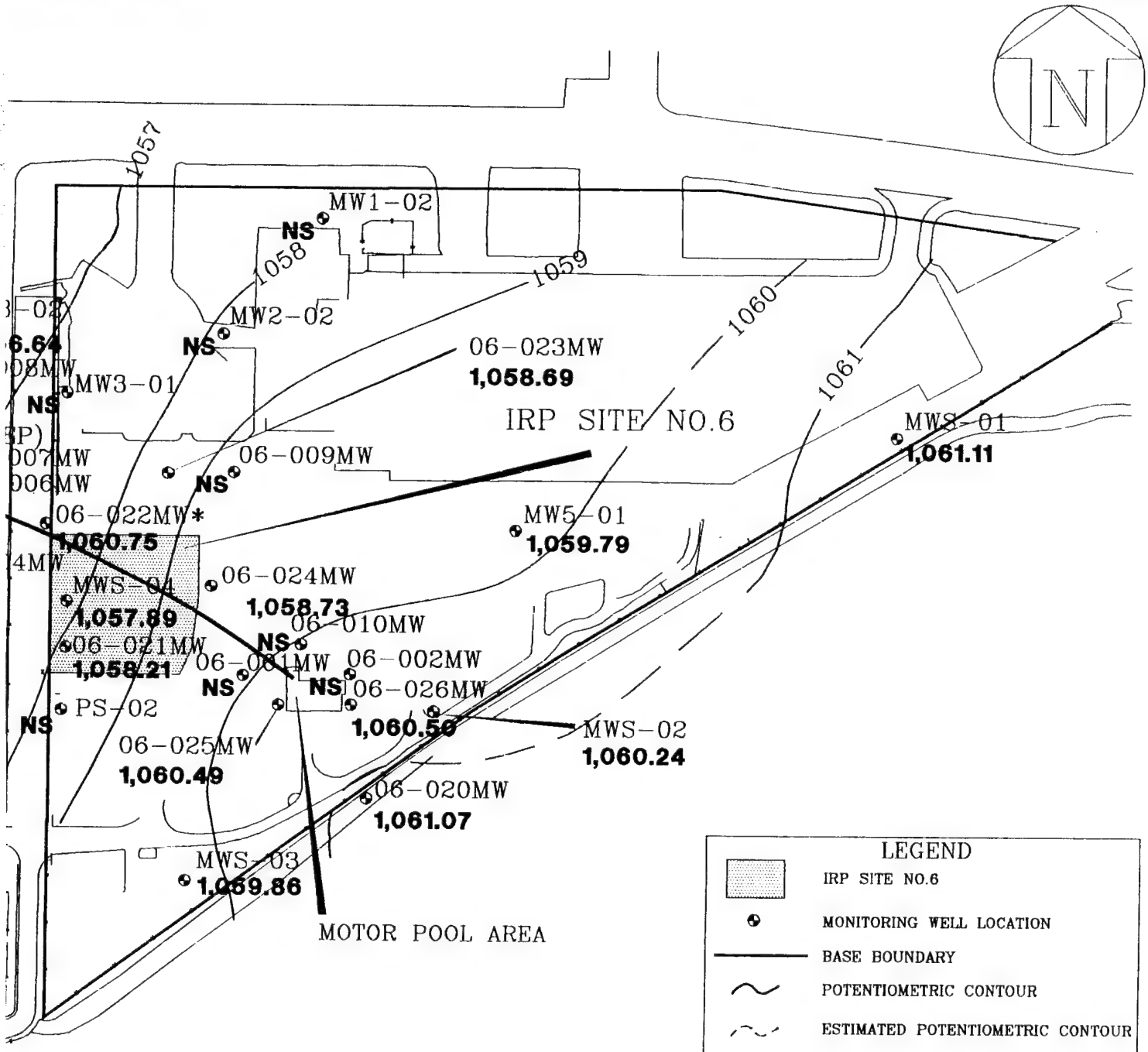
SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 5.1

SKYHARBO\1315-227\MON-3

POTENTIOMETRIC SU
ON 10-14 JUL

161st ARG, Arizona Air
Sky Harbor Internati
Phoenix, Ari



LEGEND

- IRP SITE NO.6
- MONITORING WELL LOCATION
- BASE BOUNDARY
- POTENTIOMETRIC CONTOUR
- ESTIMATED POTENTIOMETRIC CONTOUR
- 1057.66 ELEVATION OF WATER TABLE MSL
- NS NOT SAMPLED
- GROUNDWATER FLOW DIRECTION

CONTOUR INTERVAL IS LOGARITHMIC

0 250 500

SCALE IN FEET

VATER LEVELS WERE RECORDED DURING THE JULY
ING EVENT.

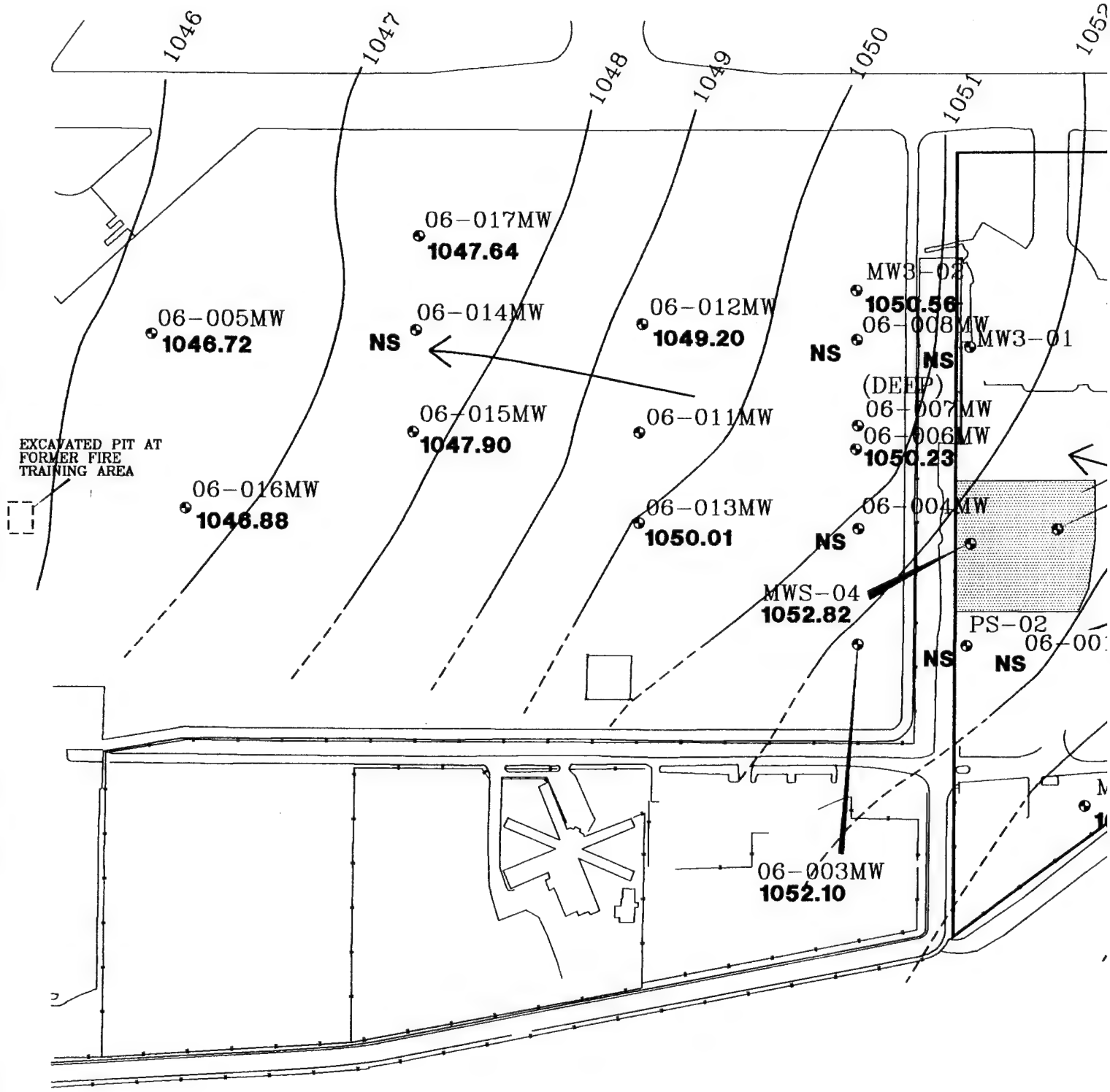
ENTIOMETRIC VALUE WAS DEEMED TO BE ANOMALOUS
ARDED.

METRIC SURFACE MAP
0-14 JULY 1995

rizona Air National Guard
or International Airport
hoenix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

MARCH 1996



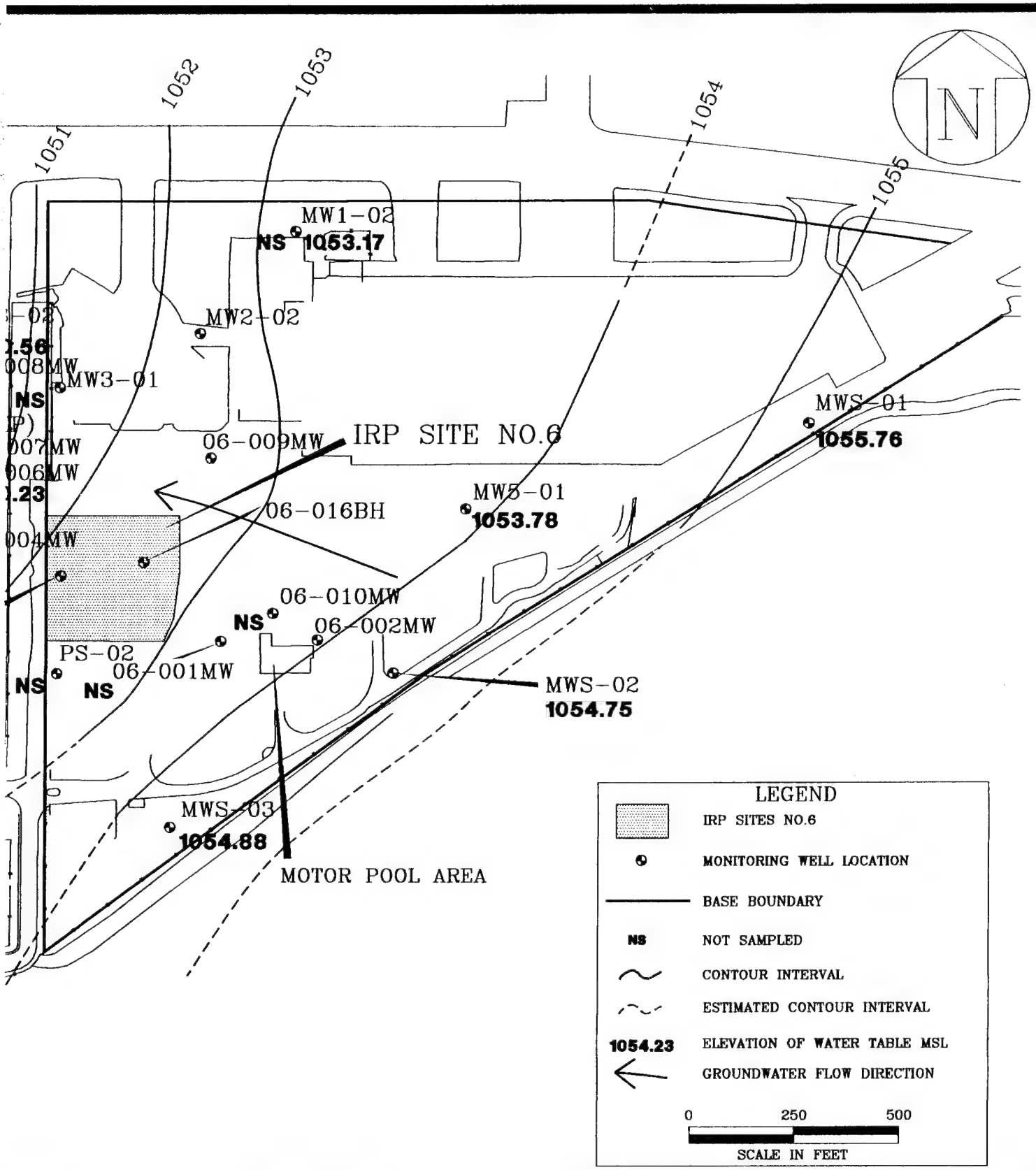
SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 5.2

SKYHARBO\1315-227\MON-TWO

POTENTIOMETRIC SURFACE MA

161st ARG, Arizona Air N
Sky Harbor Internatio
Phoenix, Ariz

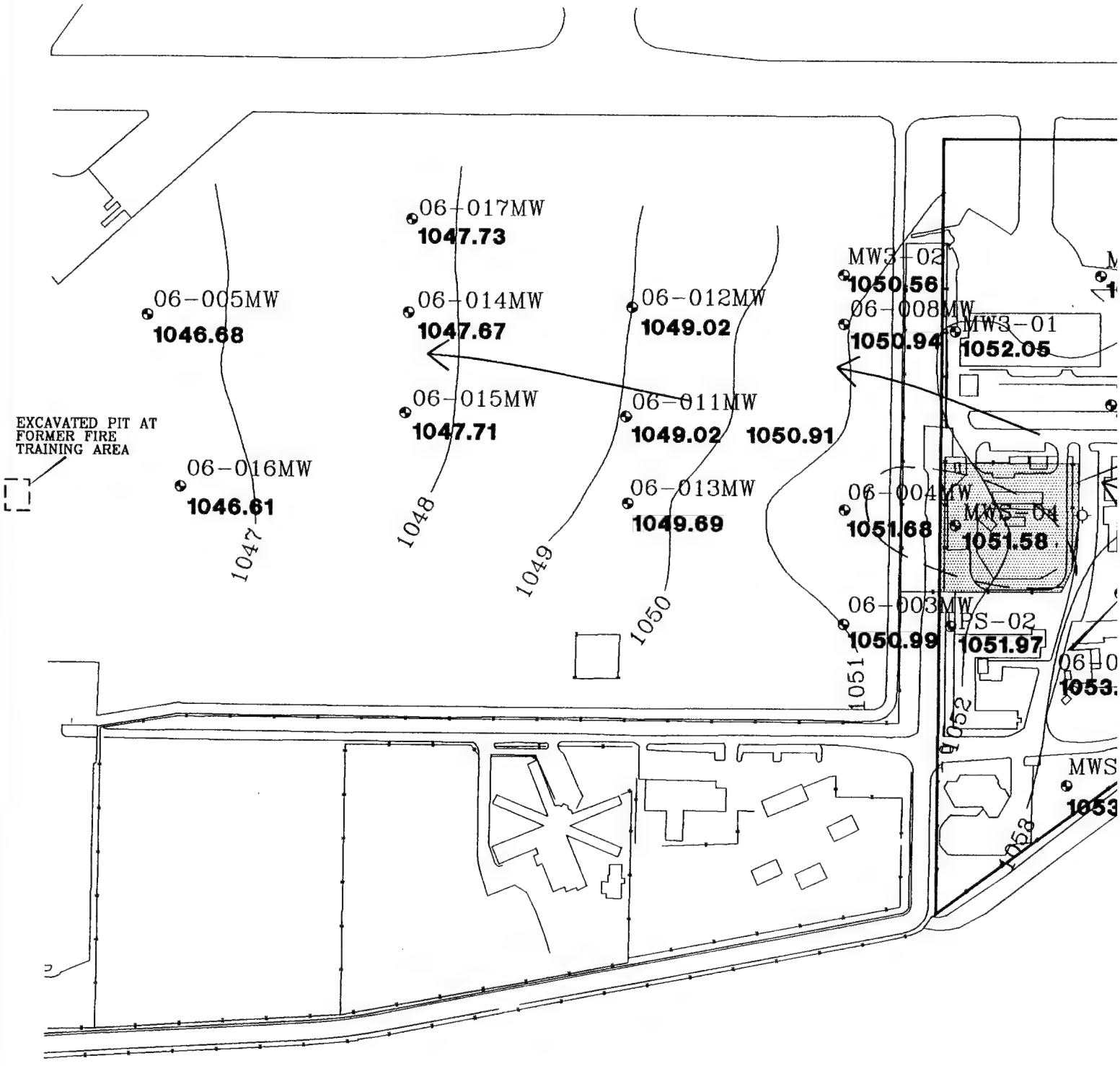


RFACE MAP FOR JANUARY 1995

Arizona Air National Guard
or International Airport
Phoenix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

APRIL 1996

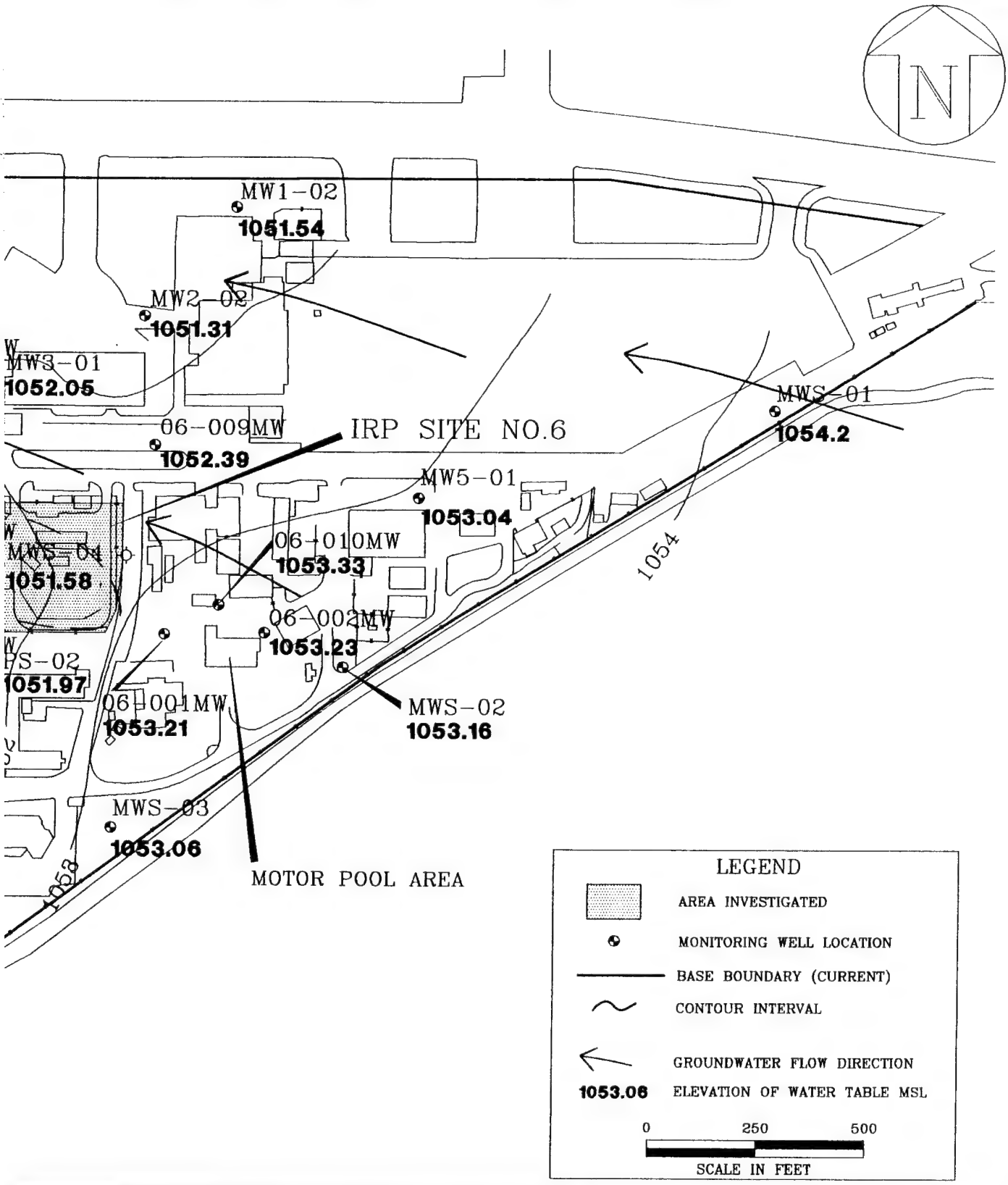


SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 5.3

SKYHARBO\1315-227\MON-WELL

POTENTIOMETRIC SURF
ON 26-30 JULY
161st ARG, Arizona Air Na
Sky Harbor Internation
Phoenix, Arizo



RIC SURFACE MAP
0 JULY 1994
na Air National Guard
ıternational Airport
nix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

MARCH 1996

5.2.3 Soil Investigation Findings

5.2.3.1 Microbiological Investigation Findings

Two subsurface soil samples were collected and analyzed for microbiological parameters. The samples were collected from an area of known high contamination based upon the RI results (OpTech, 1995).

Soil samples were analyzed for the following microbiological parameters or parameters associated with bioremediation: total heterotrophs (SM 9215), total hydrocarbon degraders, pH (SW 9040), moisture (SM 2540), nitrate- and nitrite-nitrogen (USEPA Method 353.3), and phosphorous (USEPA Method 365.2). The results of these analyses are given in Table 5.3. These results indicate low levels of microbiological organisms, soil moisture, and nitrate. Phosphorus and nitrite-nitrogen levels are high enough to support microbiologic activity. For bioremediation to be a viable remediation option, it would require microbiological augmentation.

Table 5.3
Microbiological Analysis Results
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Sample Borehole and Interval (Feet BLS)	pH	Moisture Content (%)	Nitrogen Nitrate (mg/kg)	Nitrate (mg/kg)	Phosphorus (mg/kg)	Total Hetero-trophs (CFU/g)	Hydrocarbon Degraders (CFU/g)
06-016BH 46.0 – 47.5	9.7	4.9	73.0	0.77	0.39	<10	<10
06-016BH 50.0 – 51.1	9.0	1.7	43.1	0.44	0.95	30	<10

BLS – Below Land Surface.
mg/kg – milligrams per kilogram.
CFU/g – Colony Forming Units per gram.
BH – Borehole.

5.2.3.2 Geotechnical Investigation Findings

Two soil samples contained in 6-inch brass sleeves were submitted to Core Lab Petroleum Services of Carrollton, Texas, for geotechnical laboratory testing. Permeability and a sieve analysis were performed on soil samples collected from monitoring wells 06-023MW (39.0 – 40.0 feet BLS) and 06-024MW (50.0 – 50.5 feet BLS). ASTM Method D422 was used for soil classification and ASTM Method D5084 was used for analyzing permeability. The results of the sieve analysis are presented in Table 5.4.

Table 5.4
Geotechnical Investigation Results
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Classification Standards		06-023MW 39.0 – 40.0 feet BLS	06-024MW 50.0 – 50.5 feet BLS
Sieve Size	Size Class	Retained (%)	Retained (%)
No. 5	Cobble and Pebble	86.0	93.3
No. 8	Granule	2.9	2.0
No. 16	Very Coarse Sand	7.1	1.1
No. 35	Coarse Sand	2.6	0.9
No. 60	Medium Sand	0.8	0.6
No. 120	Fine Sand	0.5	0.9
No. 230	Very Fine Sand	0.1	0.7
No. 400	Coarse Silt	0.0	0.2
< No. 400	Silt and Clay	0.0	0.3

MW – Monitoring Well. BLS – Below Land Surface.

Sieve analyses of the soil sample collected from monitoring well 06-023MW at a depth of 39.0 to 40.0 feet BLS shows 88.9 percent pebbles and 11.1 percent sand. Sieve analyses of the soil sample collected from monitoring well 06-024MW at a depth of 50.0 to 50.5 feet BLS shows 95.3 percent cobble and pebbles, 4.2 percent sand, and 0.5 percent silt and clay. These results indicates both soil samples are a sandy gravel.

Permeability is the capacity of a medium for transmitting a fluid and is measured by the rate at which a fluid can move a given distance in a given interval of time. The permeability of the soil sample collected from monitoring well 06-023MW at a depth of 39.0 to 40.0 feet BLS was determined to be 9.73×10^{-8} meters per second (m/sec) (9.73×10^{-6} centimeters per second (cm/sec)) and the permeability of the soil sample collected from monitoring well 06-024MW at a depth of 50.0 to 50.5 feet BLS was determined to be 4.42×10^{-8} m/sec (4.42×10^{-6} cm/sec). According the United States Department of Agriculture (USDA), this permeability is very low for a sandy gravel (USDA, 1974). Due to the coarse nature of the substrata it was not possible to collect a complete, undisturbed sample. To compensate the laboratory substituted a testing method that used an inch cube "plug" for testing. Due to the plug's small size, the size of the gravels and pebbles in the sleeve, the sample was not representative and as a result, the values reported are erroneously low.

5.2.3.3 Percolation Test

A percolation test was completed to determine preliminary hydrogeologic data in the vadose zone. The percolation test was conducted to evaluate discharge options of treated water. Results of the test completed at monitoring well 06-023MW are shown in Table 5.5. These results indicated a high infiltration rate of 448 gallons per day per foot squared (gal/day/ft^2).

Table 5.5
Results of Percolation Test
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Elapsed Time	Rate of Decline in Water Levels		Rate of Percolation
Minutes	ft/hr	gal/hr	gal/day/ft^2
60	3.174	10.5	570.24
120	2.874	9.5	515.76
180	2.936	9.73	528.24
240	2.474	8.15	442.56
300	2.189	7.23	392.64
360	1.982	6.61	360
420	1.841	6.03	327.36

ft/hr – Feet per hour.
gal/hr – Gallons per hour.
gal/day/ft^2 – Gallons per day per foot squared.

5.2.4 Groundwater Findings

Five rounds of groundwater sampling have been conducted at the base prior to this investigation. The sampling round conducted from July to August 1995 will be referred to as the July – August 1995 groundwater sampling event.

5.2.4.1 VOC Contamination

Twenty-two investigative groundwater samples were submitted for laboratory analysis from the nine newly installed monitoring wells and 13 pre-existing monitoring wells during the July-August 1995 groundwater sampling event. Twenty-two VOCs – benzene, toluene, ethylbenzene, total xylenes, TCE, DCE, tetrachloroethylene (PACE), chloroform, carbon tetrachloride, styrene, isopropylbenzene, N-propyl-benzene, 1,3,5-trimethylbenzene,

1,1-dichloroethane, 1,2,4-trimethylbenzene, sec-butylbenzene, P-isopropyltoluene, 1,2,3-trichloropropane, N-butylbenzene, hexachlorobutadiene, chloromethane, and naphthalene – were detected in 21 groundwater samples and four field duplicates (Tables 5.6 and 5.7). Due to dilution, detection limits were elevated for groundwater sampled from monitoring well 06-021MW.

Twenty-five VOCs have been detected in groundwater samples collected from all groundwater sampling events at IRP Site No. 6. The results from all six groundwater sampling events are included in Tables E.1 and E.2 in Appendix E. VOCs were assessed based upon the action levels contained in ADEQ's Human Health-Based Guidance for the Levels for Ingestion of Contaminants in Drinking Water and Soil (ADEQ, 1990). Components for which ADEQ Action Levels (AALs) are available were termed primary and are listed in Table E.1. Components for which AALs are not available were termed secondary and are listed in Table E.2.

Benzene was detected at concentrations ranging from 0.2 to 4,200 micrograms per liter (μg/L), exceeding the ADEQ action level of 5 μg/L, in groundwater samples from 17 monitoring wells: MWS-03, MWS-04, MW3-02, MW5-01, 06-003MW, 06-012MW, 06-013MW, 06-015MW, 06-018MW, 06-019MW, 06-020MW, 06-021MW, 06-022MW, 06-023MW, 06-024MW, 06-025MW, and 06-026MW. Benzene concentrations detected in groundwater samples collected during the July – August 1995 sampling event and the January 1995 sampling event are presented as Figures 5.4 and 5.5, respectively.

Ethylbenzene was detected at concentrations ranging from 0.4 to 750 μg/L, exceeding the ADEQ action level of 700 μg/L in the groundwater sample collected from monitoring well 06-021MW. Ethylbenzene concentrations detected in groundwater samples collected during the July – August 1995 sampling event and the January 1995 sampling event are presented as Figures 5.6 and 5.7, respectively.

TCE was detected at concentrations of 0.5 and 7.0 μg/L, exceeding the ADEQ action level of 5 μg/L in the groundwater sample collected from monitoring well 06-016MW. The source of the TCE is unknown; however, east across the Salt River, and upgradient of the base is the Estes Landfill. The Estes Landfill is a site of known TCE and DCE contamination migrating westward in the general direction of the base.

Table 5.6
Primary List of VOCs Detected during the July-August 1995 Groundwater Sampling Event IRP Site No. 6
161st Air National Guard, Arizona ANG, Phoenix, Arizona

Sample ID Number	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	TCE (µg/L)	DCE (µg/L)	PACE (µg/L)	Carbon tetra-chloride (µg/L)	Chloro-form (µg/L)	Styrene (µg/L)
MWS-01	4	0.4B	8	4B	<0.32	<0.27	<0.33	<0.11	<0.15	<0.23
MWS-02	<0.03	<0.06	<0.03	<0.09	<0.32	<0.27	<0.33	<0.11	<0.15	<0.23
MWS-03	**8**	0.2B	12	2B	<0.32	<0.27	<0.33	<0.11	0.15	<0.23
MWS-04	**4,200**	2B	500	19B	<0.32	<0.27	<0.33	<0.11	<0.15	3
MWS-04 Dup	**4,000**	3B	480	20B	<0.32	<0.27	<0.33	<0.11	<0.15	<4.6
MW3-02	**15**	0.4B	16	3B	<0.32	0.3	<0.33	<0.11	<0.15	<0.23
MW5-01	**6**	0.3B	9	2B	<0.32	<0.27	<0.33	<0.11	<0.15	<0.23
MW5-01 Dup	**7**	0.2B	8	2B	<0.32	<0.27	<0.33	<0.11	<0.15	<0.23
06-003MW	**19**	0.5B	21	3B	<0.32	<0.27	<0.33	<0.11	0.2	<0.23
05-005MW	0.6	<0.06	1	1	<0.32	<0.27	<0.33	<0.11	<0.15	<0.23
06-005MW Dup	1	<0.06	3	2	<0.32	<0.27	<0.33	<0.11	<0.15	<0.23
06-012MW	**29**	0.6B	26	3B	<0.32	<0.27	<0.33	<0.11	0.2	1
06-013MW	**670**	0.7B	41	4B	<0.32	<0.27	<0.33	<0.11	<0.15	<0.23
06-015MW	**74**	0.4B	55	4B	<0.32	<0.27	<0.33	<0.11	<0.15	<0.23
06-016MW	<0.03	<0.06	0.4	0.4	**7**	<0.27	**0.8**	**0.2**	<0.15	<0.23

Table 5.6 (Concluded)
Primary List of VOCs Detected During the July-August 1995 Groundwater Sampling Event
IRP Site No. 6, 161st ARG, Arizona Air National Guard, Phoenix, Arizona

Sample ID Number	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	TCE (µg/L)	DCE (µg/L)	PACE (µg/L)	Carbon tetra-chloride (µg/L)	Chloro-form (µg/L)	Styrene (µg/L)
06-017MW	0.2	<0.06	0.8	0.8B	<0.32	<0.27	<0.33	<0.11	<0.15	<0.23
06-018MW	**6**	1	6	3	<0.32	0.4	<0.33	<0.11	0.2	<0.23
06-019MW	**5**	1	4	3	<0.32	<0.27	<0.33	<0.11	<0.15	0.6
06-020MW	**36**	4	29	29	0.5	0.4	<0.33	<0.11	0.3	<0.23
06-021MW*	**1,800**	<3	**750**	150	<16	<13.5	<0.33	<0.11	<7.5	20
06-022MW	**1,400**	13	120	33	<0.32	<0.27	<0.33	<0.11	<0.15	2
06-023MW	**1,200**	2	150	23	<0.32	<0.27	<0.33	<0.11	<0.15	3
06-024MW	**960**	64	220	200	<0.32	<0.27	<0.33	<0.11	<0.15	<0.33
06-024MW Dup	**890**	63	200	180	<0.32	<0.27	<0.33	<0.11	<0.15	<0.33
06-025MW	**15**	1	7	4	<0.32	<0.27	<0.33	<0.11	<0.15	<0.33
06-026MW	**24**	1	38	13	<0.32	<0.27	<0.33	<0.11	<0.15	<0.33
ADEQ Cleanup Levels	5	1,000	700	10,000	5	70	5	5	100	100

µg/L – micrograms per liter.
Dup – Duplicate.
DCE – Dichloroethylene.
PACE – Tetrachloroethylene.
VOCs – Volatile Organic Compounds.
* – Detect limits are elevated due to dilution.
TCE – Trichloroethylene.
IRP – Installation Restoration Program.
MWS and MW – Monitoring Well.
ADEQ – Arizona Department of Environmental Quality.

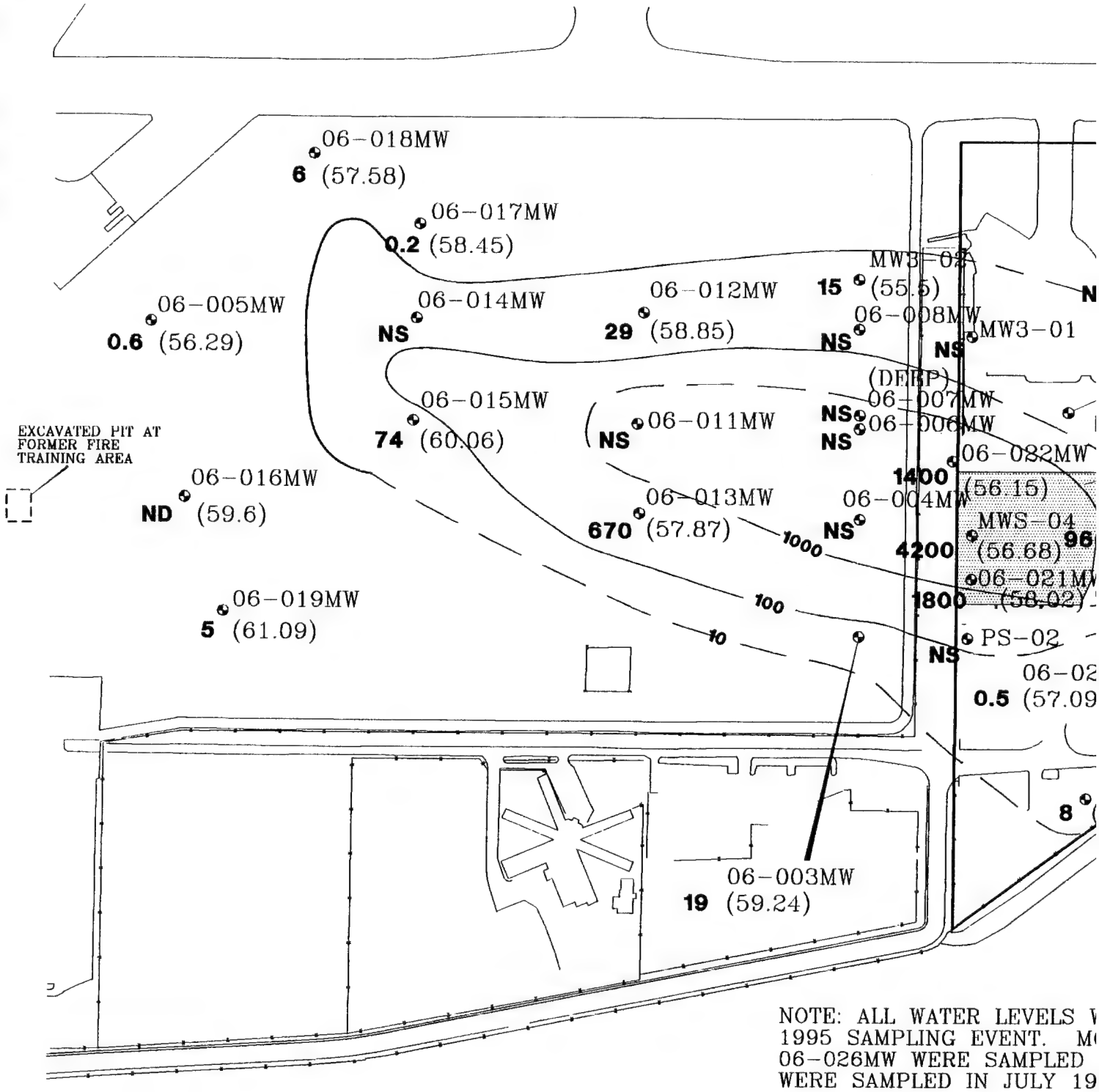
Table 5.7
Secondary List of VOCs Detected During the July-August 1995 Groundwater Sampling Event IRP Site No. 6
161st ARG, Arizona Air National Guard, Phoenix, Arizona

Sample ID Number	Isopropyl-benzene (µg/L)	N-Propyl-benzene (µg/L)	1,3,5-Trimethyl-benzene (µg/L)	1,2,4-Trimethyl-benzene (µg/L)	Sec-butyl benzene (µg/L)	P-Isopropyl-toluene (µg/L)	N-Butyl-benzene (µg/L)	1,2,3-Tri-chloro-propane (µg/L)	1,1-Dichloro-ethane (µg/L)	Chloro-methane (µg/L)	Hexa-chloro-butadiene (µg/L)	Naph-thalene (µg/L)
MWS-01	0.9	1	0.5	<0.05	<0.06	<0.1	<0.12	<0.16	<0.11	**0.5**	<0.22	2B
MWS-02	<0.1	<0.04	<0.03	<0.05	<0.06	<0.1	<0.12	<0.16	<0.11	<0.15	<0.22	<0.12
MWS-03	1	1	<0.03	2	<0.06	<0.1	0.3	<0.16	<0.11	**2**	<0.22	5B
MWS-04	25	28	1	<0.05	3	0.9	6	<0.16	<0.11	**3**	<0.22	<0.12
MWS-04 Dup	25	28	2	<0.05	3	0.9	6	<0.16	<0.11	**3**	<0.22	58B
MW3-02	2	2	0.3	<0.05	<0.06	<0.1	0.3	<0.16	<0.11	**1**	<0.22	2B
MW5-01	0.9	0.9	<0.03	1	<0.06	<0.1	<0.12	<0.16	<0.11	<0.15	<0.22	2B
MW5-01 Dup	0.8	0.9	<0.03	1	<0.06	<0.1	<0.12	<0.16	<0.11	**0.4**	<0.22	2B
06-003MW	2	2	0.3	<0.05	0.2	<0.1	0.4	**0.9**	<0.11	**2**	<0.22	3B
06-005MW	<0.1	<0.04	<0.03	0.6	<0.06	<0.1	<0.12	<0.16	**0.2**	**0.4**	<0.22	1
06-005MW Dup	0.3	0.3	0.2	0.7	0.06	<0.1	<0.12	<0.16	<0.11	**1**	<0.22	1
06-012MW	3	2	0.3	<0.05	0.3	<0.1	0.4	<0.16	<0.11	**3**	<0.22	3B
06-013MW	18	10	0.8	<0.05	2	<0.1	2	<0.16	<0.11	**0.4**	<0.22	9B
06-015MW	4	4	0.5	<0.05	0.3	<0.1	0.5	**0.5**	<0.11	**2**	<0.22	<0.12
06-016MW	<0.1	<0.04	<0.03	0.3	<0.06	<0.1	<0.12	<0.16	<0.11	**2**	**0.3**	2

Table 5.7 (Concluded)
Secondary List of VOCs Detected During the July-August 1995 Groundwater Sampling Event IRP Site No. 6
161st ARG, Arizona Air National Guard, Phoenix Arizona

Sample ID Number	Isopropyl-benzene (µg/L)	N-Propyl -benzene (µg/L)	1,3,5-Trimethyl-benzene (µg/L)	1,2,4-Trimethyl-benzene (µg/L)	Sec-butyl benzene (µg/L)	P-Isopropyl-toluene (µg/L)	N-Butyl-benzene (µg/L)	1,2,3-Tri-chloro-propane (µg/L)	1,1-Dichloro-ethane (µg/L)	Chloro-methane (µg/L)	Hexa-chloro-butadiene (µg/L)	Naph-thalene (µg/L)
06-017MW	<0.1	<0.04	<0.03	<0.05	<0.06	<0.1	<0.12	<0.16	<0.11	<0.15	<0.22	<0.12
06-018MW	0.7	0.7	0.4	1	<0.06	<0.1	0.5	<0.16	<0.11	<0.15	<0.22	2
06-019MW	0.7	0.7	0.4	1	<0.06	<0.1	0.4	<0.16	<0.11	<0.15	<0.22	4
06-020MW	2	1	2	<0.05	0.2	0.2	1	<0.16	<0.11	<0.15	<0.22	4
06-021MW*	51	56	15	110	<3	<5	21	<0.16	<0.11	<0.15	<0.22	120
06-022MW	18	21	6	<0.05	3	2	9	<0.16	<0.11	<0.15	<0.22	58
06-023MW	30	27	3	<0.05	4	0.4	4	<0.16	<0.11	<0.15	<0.22	17
06-024MW	22	18	15	61	3	1	7	<0.16	<0.11	<0.15	<0.22	30
06-024MW Dup	31	18	16	61	3	1	17	<0.16	<0.11	<0.15	<0.22	27
06-025MW	1	1	0.5	2	2	0.3	6	<0.16	<0.11	<0.15	<0.22	2
06-026MW	3	4	2	<0.05	0.4	0.4	<0.12	<0.16	<0.11	<0.15	<0.22	6

µg/L – micrograms per liter.
MWS and MW – Monitoring Well.
VOCs – Volatile Organic Compounds.
* – Detection limits are elevated due to dilution.
IRP – Installation Restoration Program.
Dup – Duplicate.

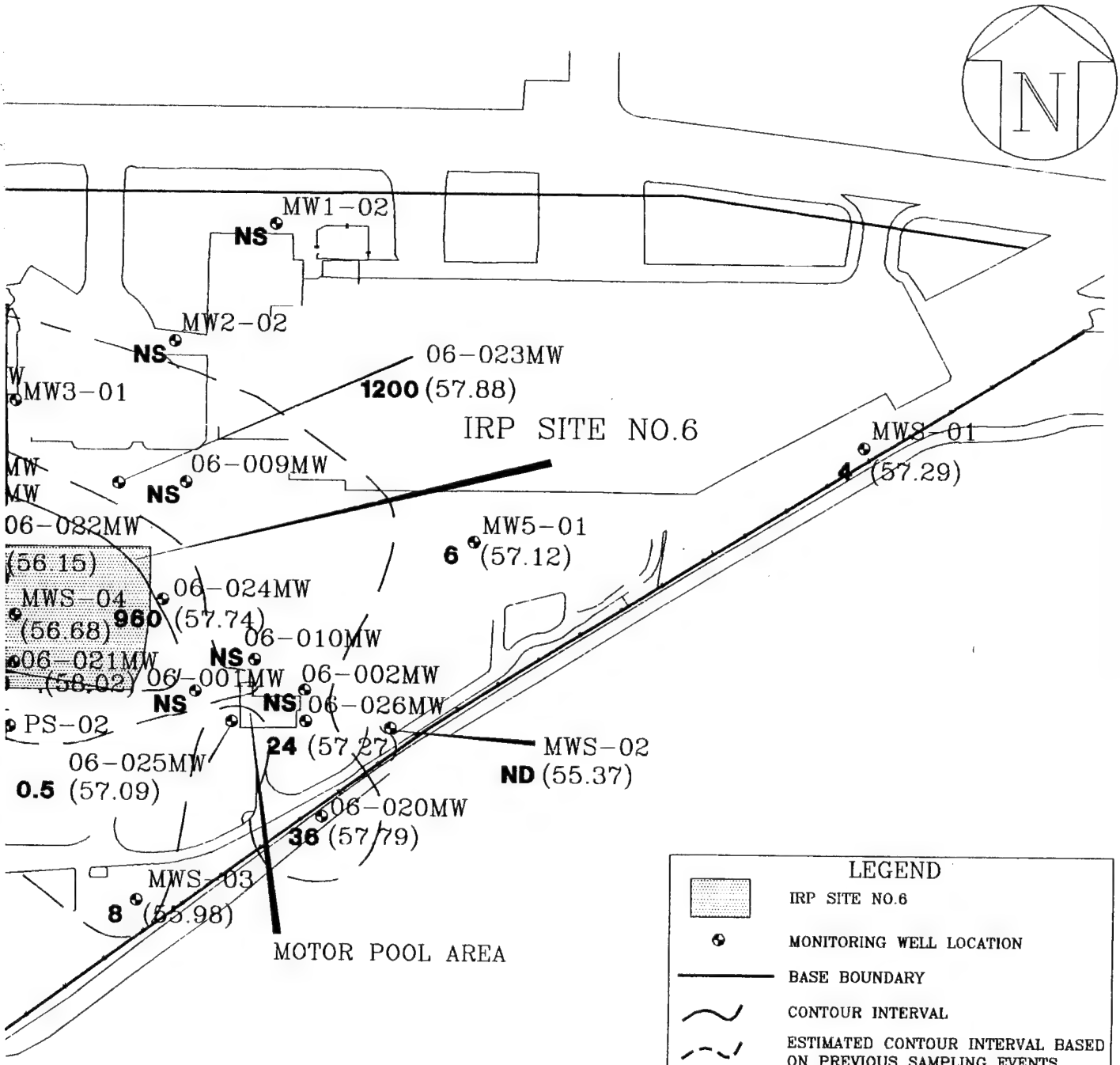


SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 5.4

SKYHARBO\1315-227\MON-3

BENZENE DETECTED IN
(10-14 JULY AND 8-1(
GROUNDWATER
161st ARG, Arizona Air
Sky Harbor Internati
Phoenix, Ari



R LEVELS WERE RECORDED DURING THE JULY
EVENT. MONITORING WELL 06-018MW THROUGH
SAMPLED IN AUGUST 1995. ALL OTHER WELLS
IN JULY 1995.

LEGEND

- IRP SITE NO.6
- MONITORING WELL LOCATION
- BASE BOUNDARY
- CONTOUR INTERVAL
- ESTIMATED CONTOUR INTERVAL BASED ON PREVIOUS SAMPLING EVENTS
- **60** BENZENE ug/L
- **NS** NOT SAMPLED
- **ND** NOT DETECTED
- (57.79) DEPTH TO WATER TABLE

CONTOUR INTERVAL IS LOGARITHMIC

0 250 500

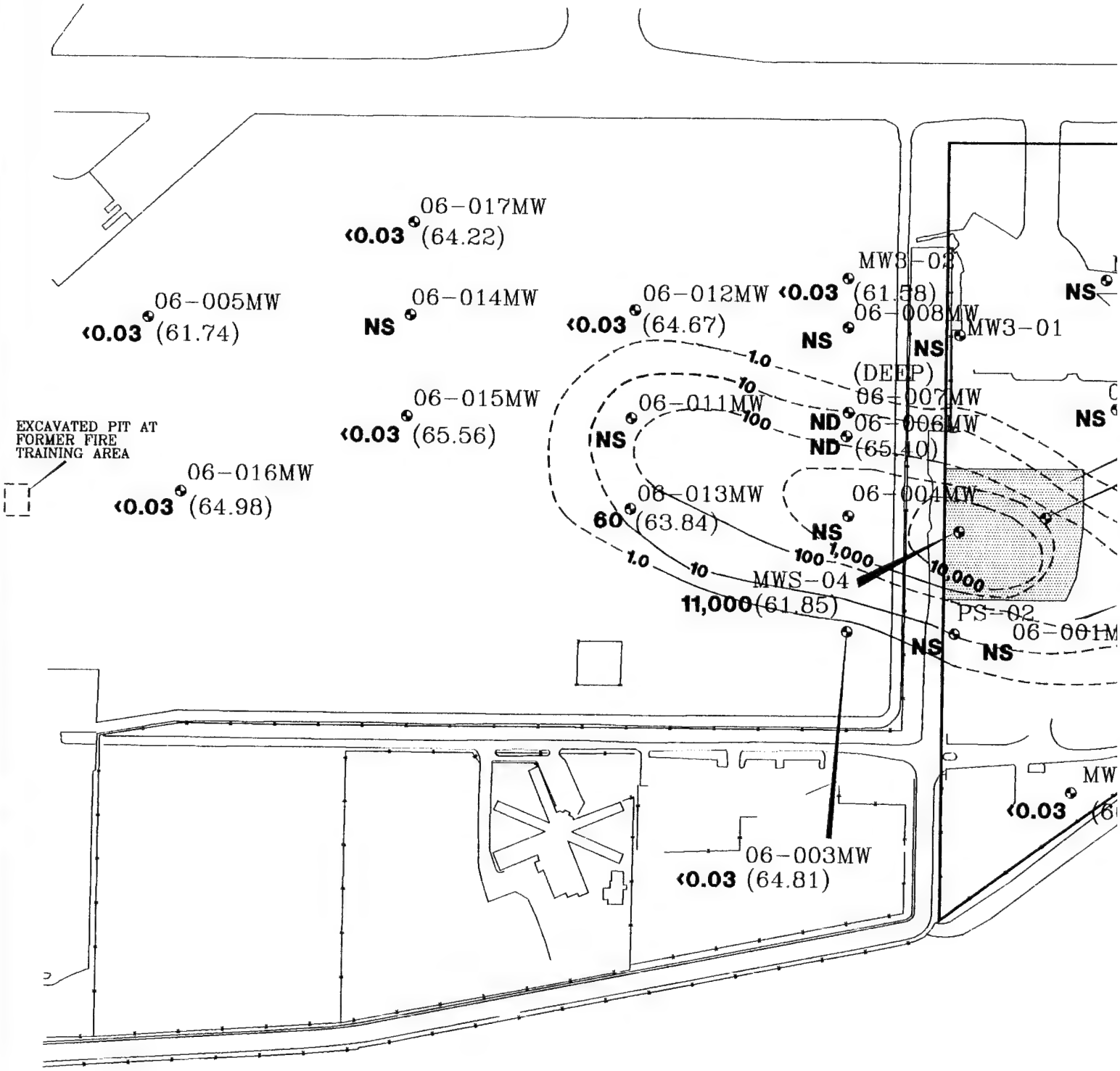
SCALE IN FEET

CTED IN SIXTH ROUND
D 8-10 AUGUST 1995)
VATER SAMPLES

ona Air National Guard
International Airport
enix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

MARCH 1996



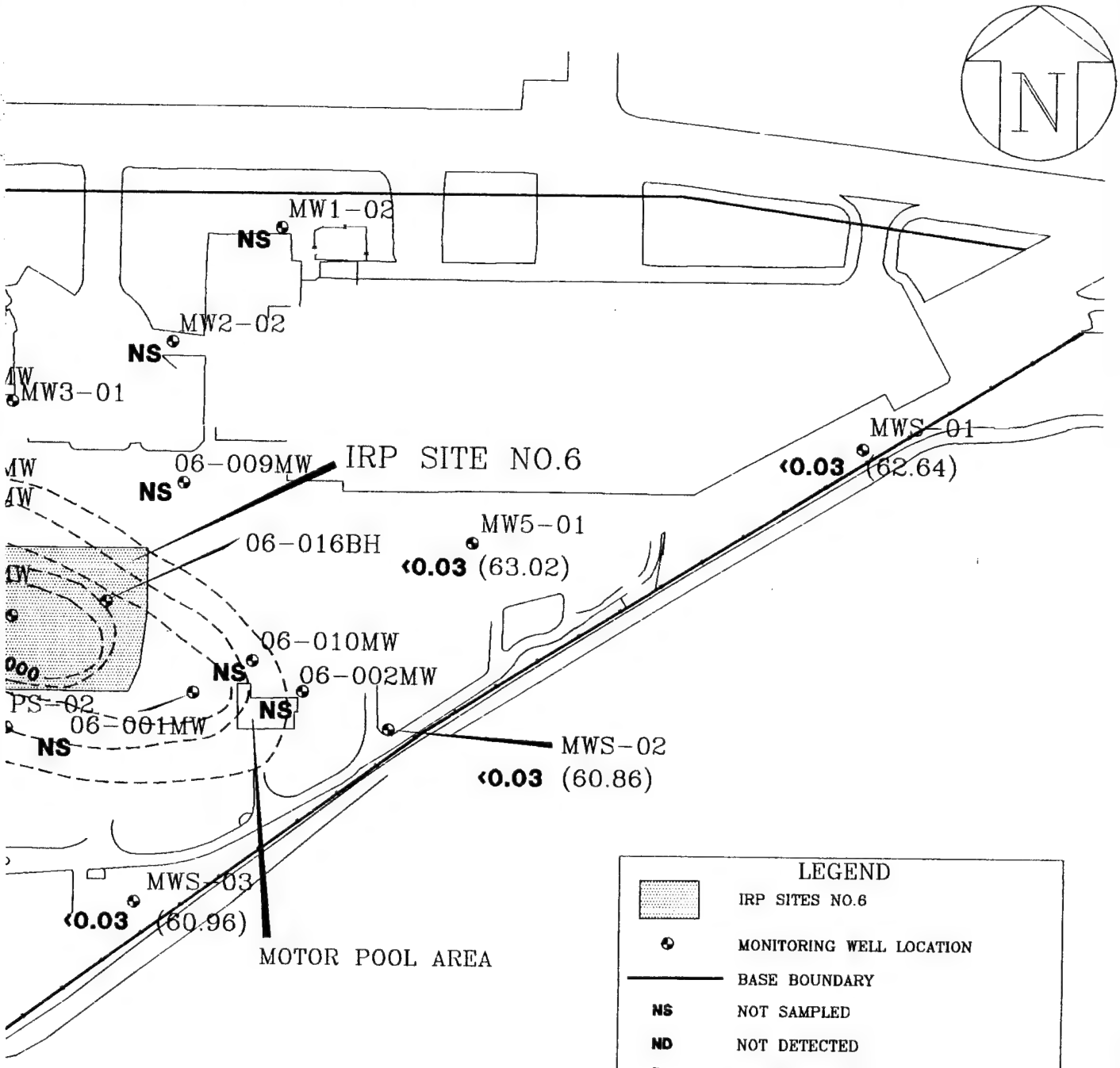
SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 5.5

SKYHARBO\1315-227\MON-TWO

BENZENE DETECTED IN GROUNDWATER SA

161st ARG, Arizona Air Na
Sky Harbor Internation
Phoenix, Arizo

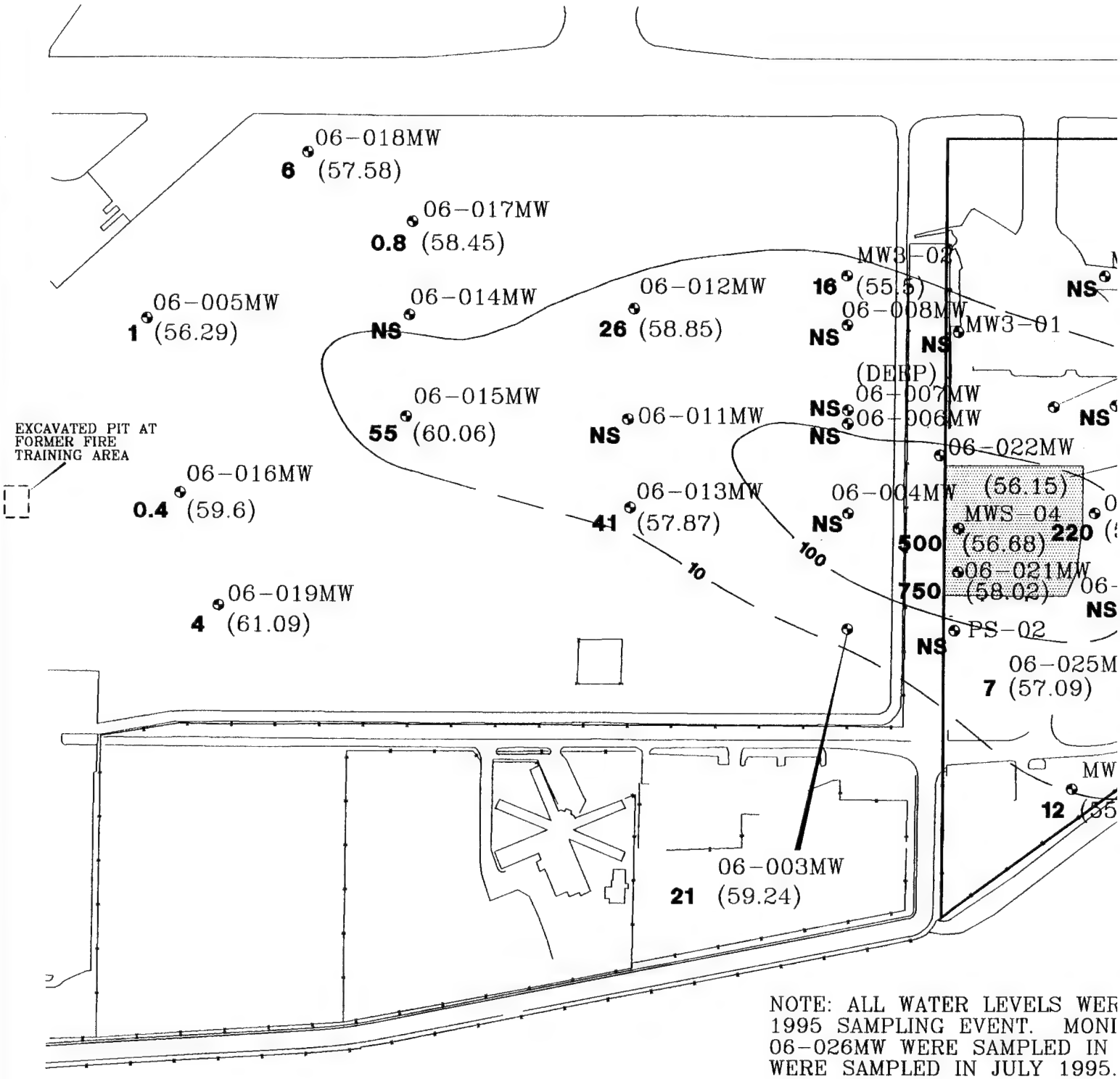


'ED IN JANUARY 1995
/ATER SAMPLES

)na Air National Guard
nternational Airport
enix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

MARCH 1996



NOTE: ALL WATER LEVELS WER
1995 SAMPLING EVENT. MONI
06-026MW WERE SAMPLED IN
WERE SAMPLED IN JULY 1995.

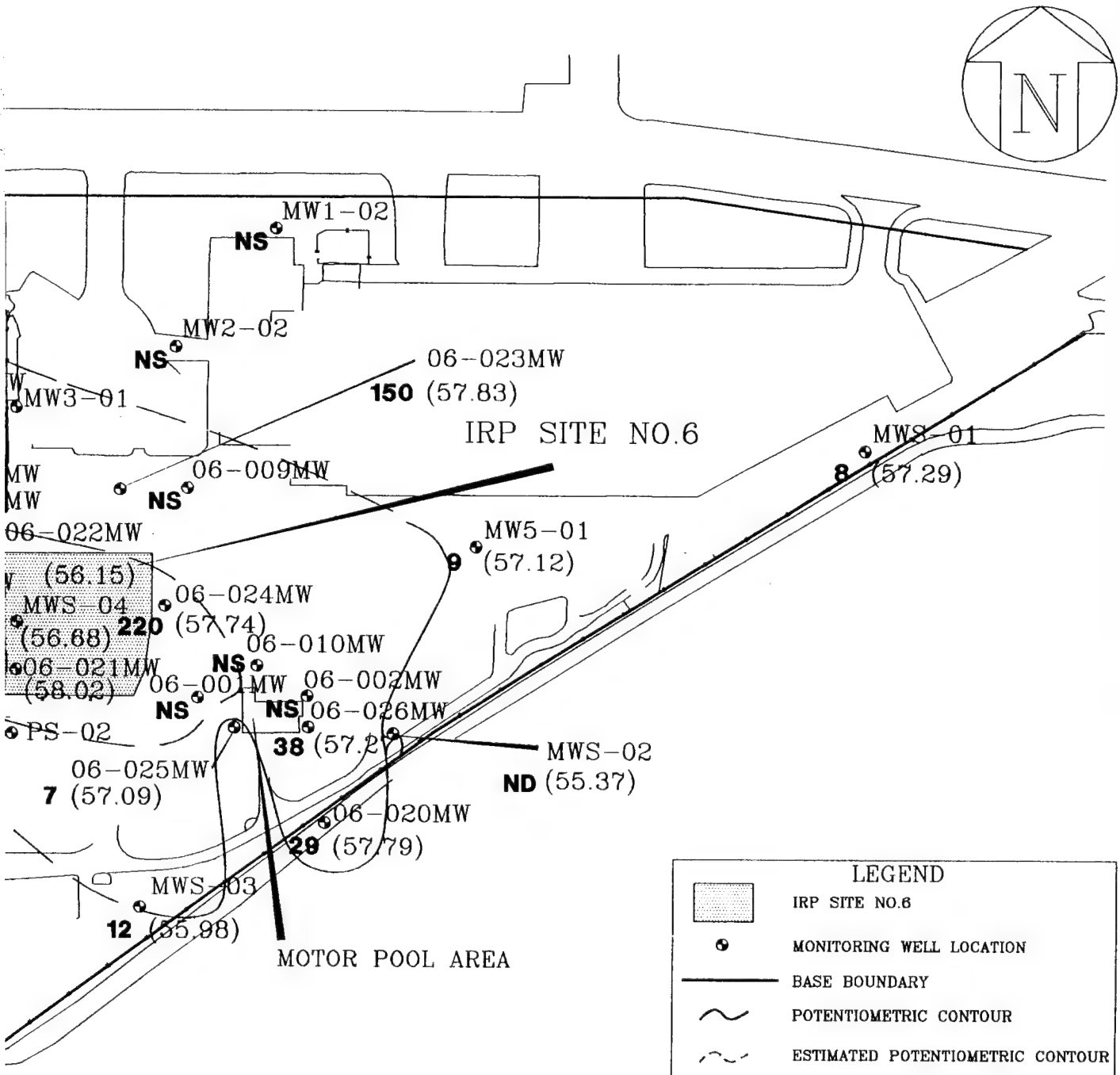
SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 5.6

SKYHARBO\1315-227\MON-3

ETHYLBENZENE DETECTED
(10-14 JULY AND 8-10
GROUNDWATER SA

161st ARG, Arizona Air Na
Sky Harbor Internation
Phoenix, Arizo



LEGEND

- IRP SITE NO.6
- MONITORING WELL LOCATION
- BASE BOUNDARY
- POTENTIOMETRIC CONTOUR
- ESTIMATED POTENTIOMETRIC CONTOUR
- 60 ETHYLBEZENE ug/L
- NS NOT SAMPLED
- (57.79) DEPTH TO WATER TABLE

CONTOUR INTERVAL IS LOGARITHMIC

0 250 500

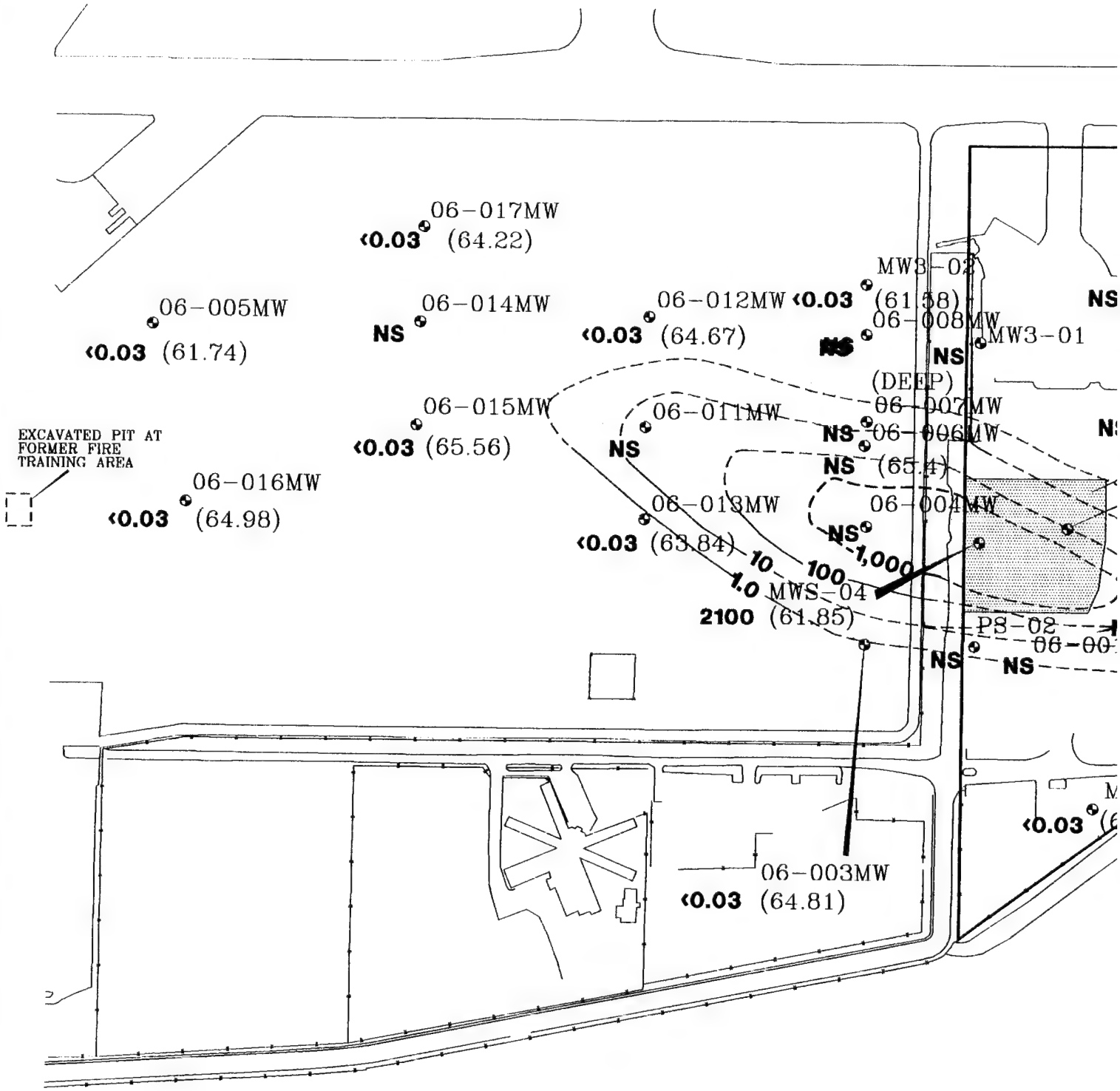
SCALE IN FEET

ER LEVELS WERE RECORDED DURING THE JULY
EVENT. MONITORING WELL 06-018MW THROUGH
E SAMPLED IN AUGUST 1995. ALL OTHER WELLS
IN JULY 1995.

TECTED IN SIXTH ROUND
D 8-10 AUGUST 1995)
WATER SAMPLES
ona Air National Guard
International Airport
enix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

APRIL 1996

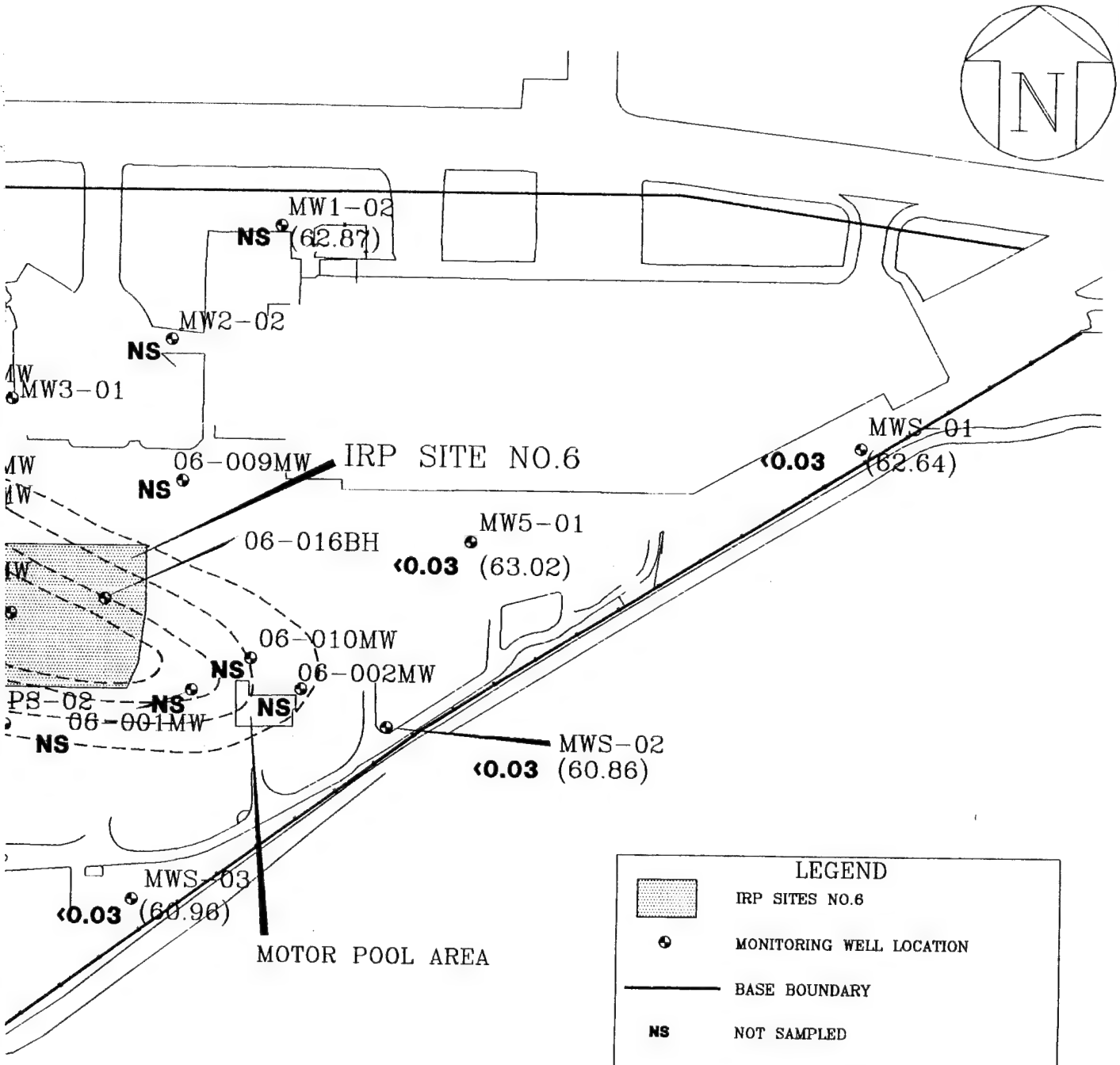


SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 5.7

SKYHARBO\1315-227\MON-TWO

ETHYLBENZENE I
IN JANUARY 1995 GROUNI
161st ARG, Arizona Air N
Sky Harbor Internatio
Phoenix, Ariz



LEGEND

- IRP SITES NO.6
- MONITORING WELL LOCATION
- BASE BOUNDARY
- NS — NOT SAMPLED
- CONTOUR INTERVAL
- ESTIMATED CONTOUR INTERVAL BASED ON PREVIOUS SAMPLING EVENTS
- (60.96) — DEPTH TO WATER FROM TOC
- 2100 — ETHYLBENZENE ug/L

CONTOUR INTERVAL IS LOGARITHMIC

0 250 500

SCALE IN FEET

NZENE DETECTED
GROUNDWATER SAMPLES
na Air National Guard
nternational Airport
enix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

MARCH 1996

Toluene, total xylenes, DCE, chloroform, and styrene were detected at concentrations below ADEQ action levels. No ADEQ action levels exist for isopropylbenzene, N-propyl-benzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, sec-butylbenzene, P-isopropyltoluene, 1,1-dichloroethane,N-butylbenzene,1,2,3-trichloropropane,hexachlorobutadiene,chloromethane and naphthalene.

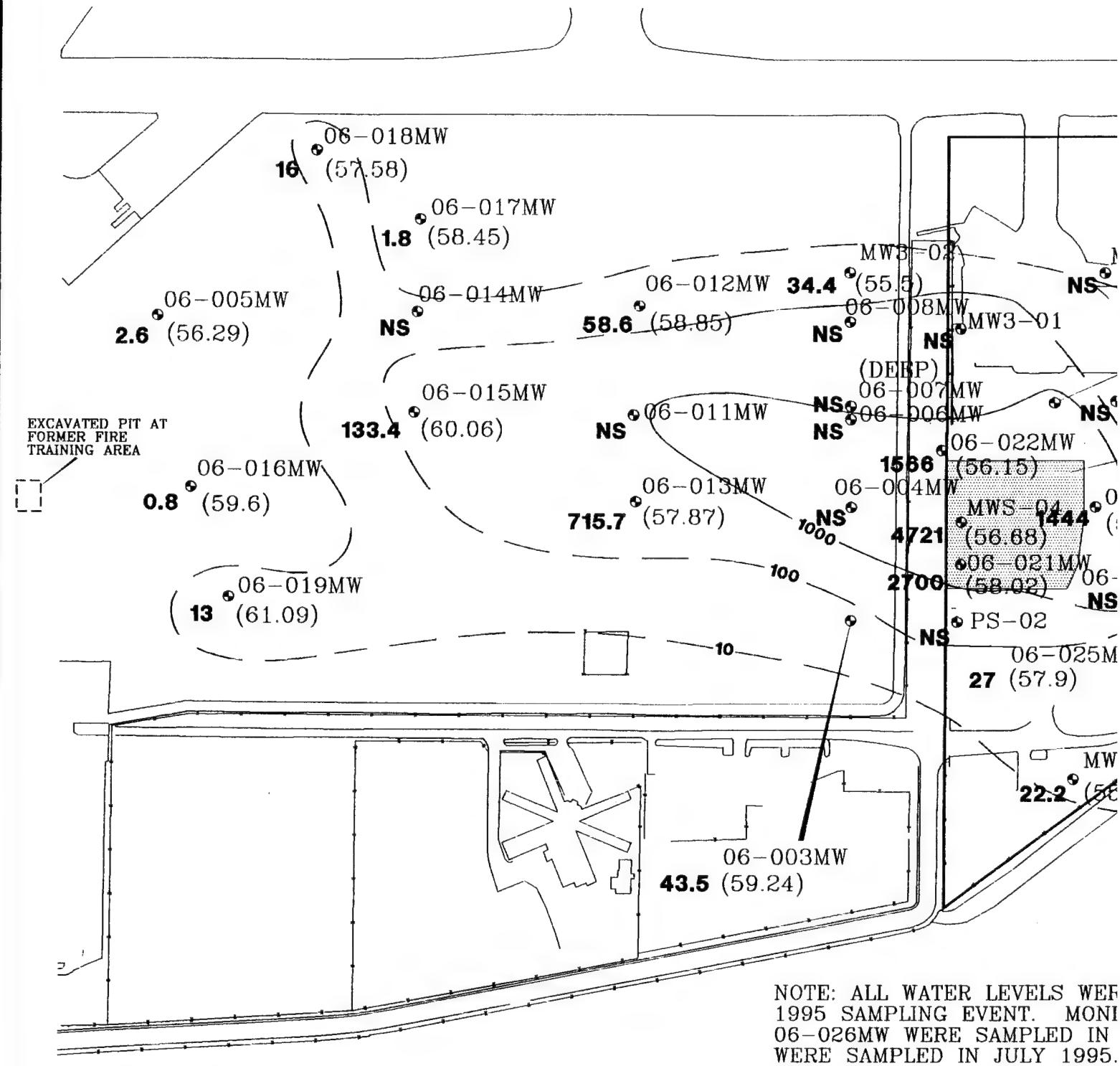
Total BTEX was detected at concentrations ranging from 0.8 to 4,721 μg/L, with the highest concentrations detected in groundwater samples collected from monitoring wells MWS-04, 06-017MW, 06-021MW, 06-022MW, 06-023MW, and 06-024MW. Total BTEX concentrations detected in groundwater samples collected during the July – August 1995 sampling event and the January 1995 sampling event are presented as Figures 5.8 and 5.9, respectively.

Groundwater analytical results indicate that VOC contamination has migrated approximately 2,100 feet downgradient from IRP Site No. 6. Contamination has also been detected upgradient at the motor pool area. Contamination was detected in monitoring wells 06-020MW, 06-025MW, 06-026MW, and MWS-03. MWS-03 has had a history of groundwater contamination and is located downgradient of the motor pool area as is 06-025MW. Monitoring well 06-020MW is located cross-gradient of the motor pool area. Monitoring well 06-029MW is located immediately upgradient of the motor pool area.

5.2.4.2 TPH Contamination

TPH was detected at concentrations ranging from 1 to 6 ppm in groundwater samples collected from monitoring wells MWS-04, 06-21MW, 06-022MW, 06-023MW, and 06-024MW. TPH concentrations detected in groundwater samples collected during the July – August 1995 sampling round is presented as Figure 5.10.

THIS PAGE INTENTIONALLY LEFT BLANK



NOTE: ALL WATER LEVELS WER
1995 SAMPLING EVENT. MONI
06-026MW WERE SAMPLED IN
WERE SAMPLED IN JULY 1995.

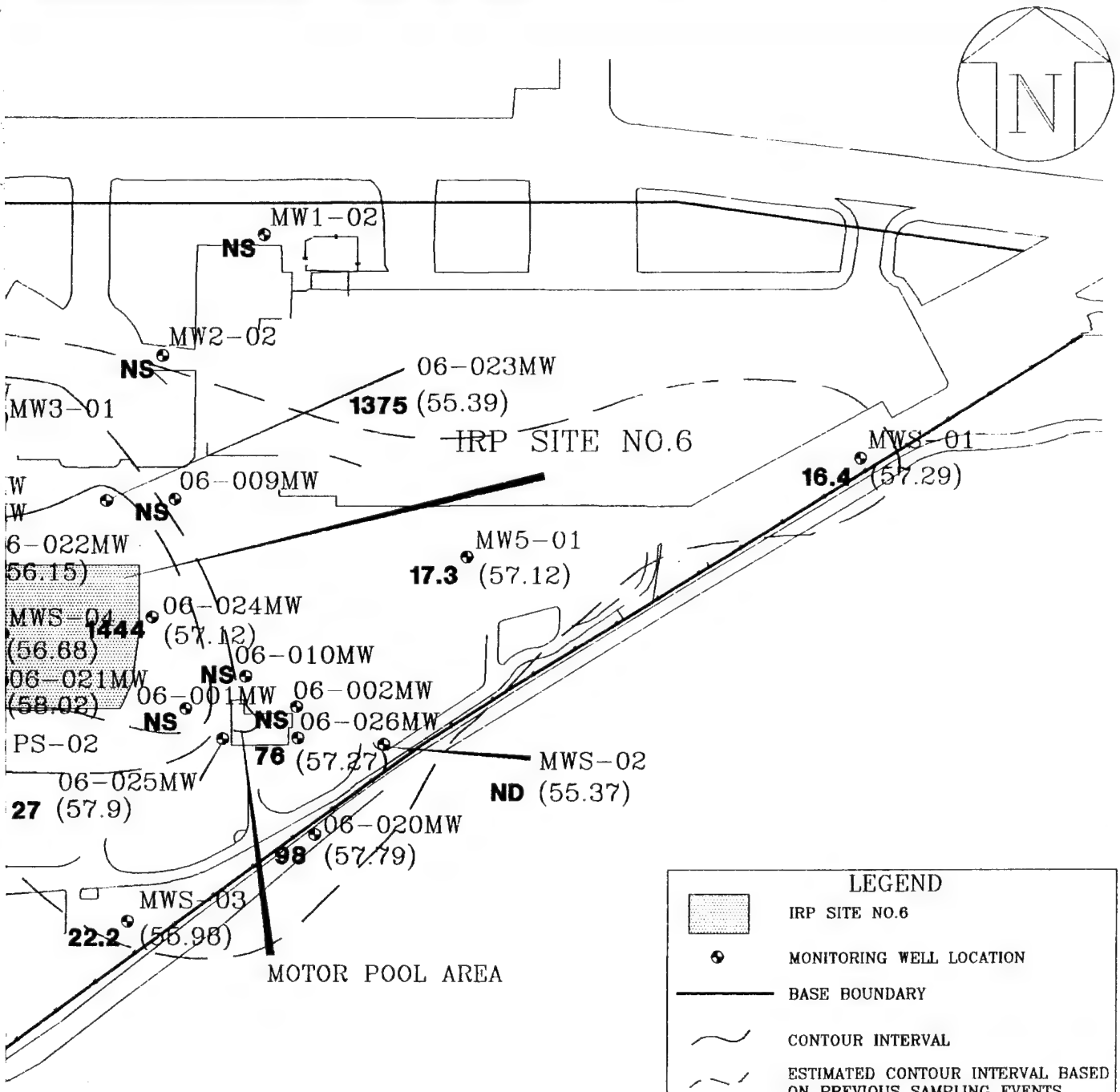
SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 5.8

SKYHARBO\1315-227\MON-3

TOTAL BTEX DETECTED IN
(10-14 JULY AND 8-10
GROUNDWATER SA

161st ARG, Arizona Air Na
Sky Harbor Internation
Phoenix, Arizo



R LEVELS WERE RECORDED DURING THE JULY
EVENT. MONITORING WELL 06-018MW THROUGH
SAMPLED IN AUGUST 1995. ALL OTHER WELLS
N JULY 1995.

LEGEND

- IRP SITE NO.6
- MONITORING WELL LOCATION
- BASE BOUNDARY
- CONTOUR INTERVAL
- ESTIMATED CONTOUR INTERVAL BASED ON PREVIOUS SAMPLING EVENTS
- 60 BTEX ug/L
- NS NOT SAMPLED
- (55.37) DEPTH TO WATER TABLE

CONTOUR INTERVAL IS LOGARITHMIC

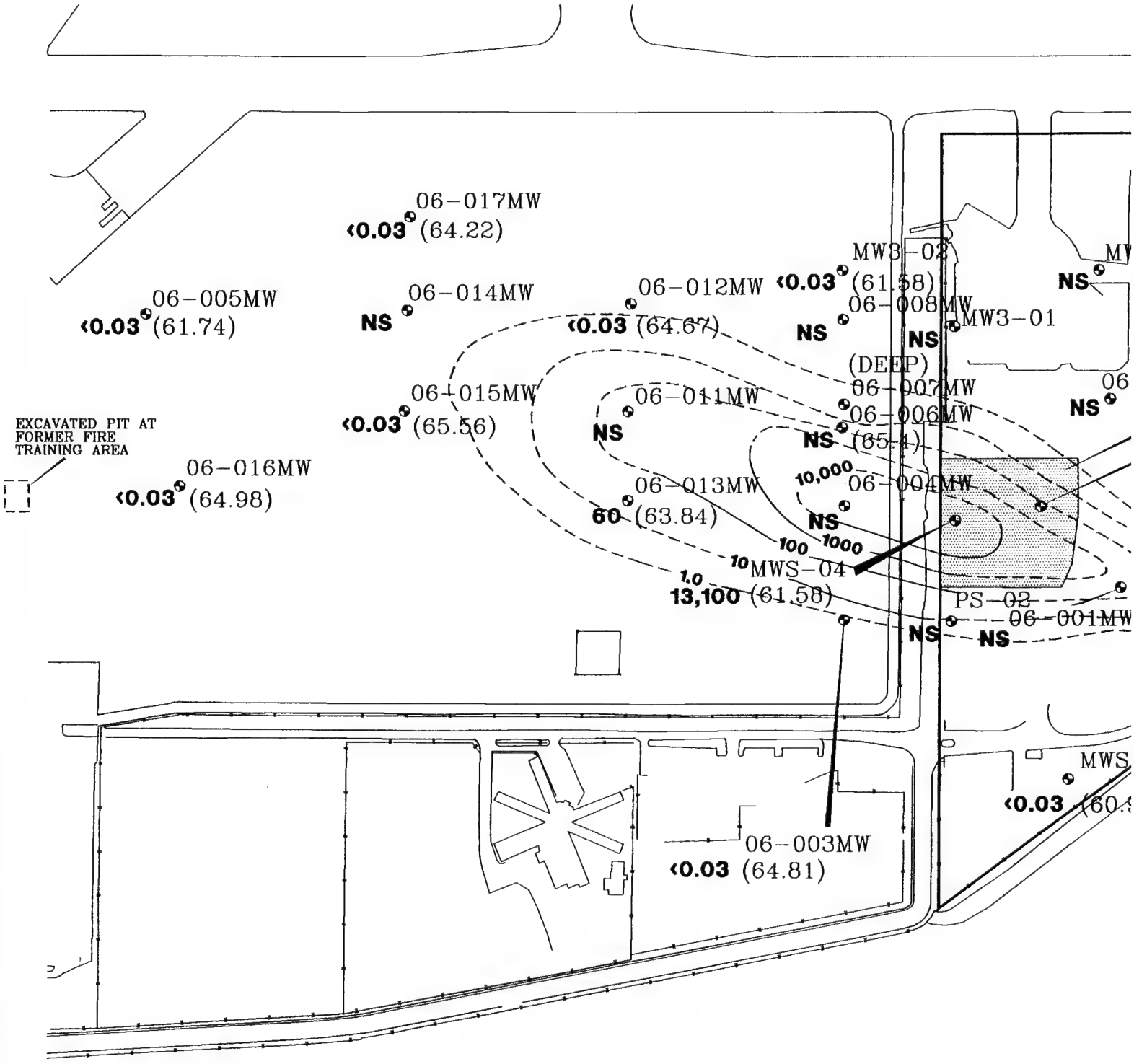
0 250 500

SCALE IN FEET

ECTED IN SIXTH ROUND
D 8-10 AUGUST 1995)
ATER SAMPLES
na Air National Guard
nternational Airport
enix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

MARCH 1996



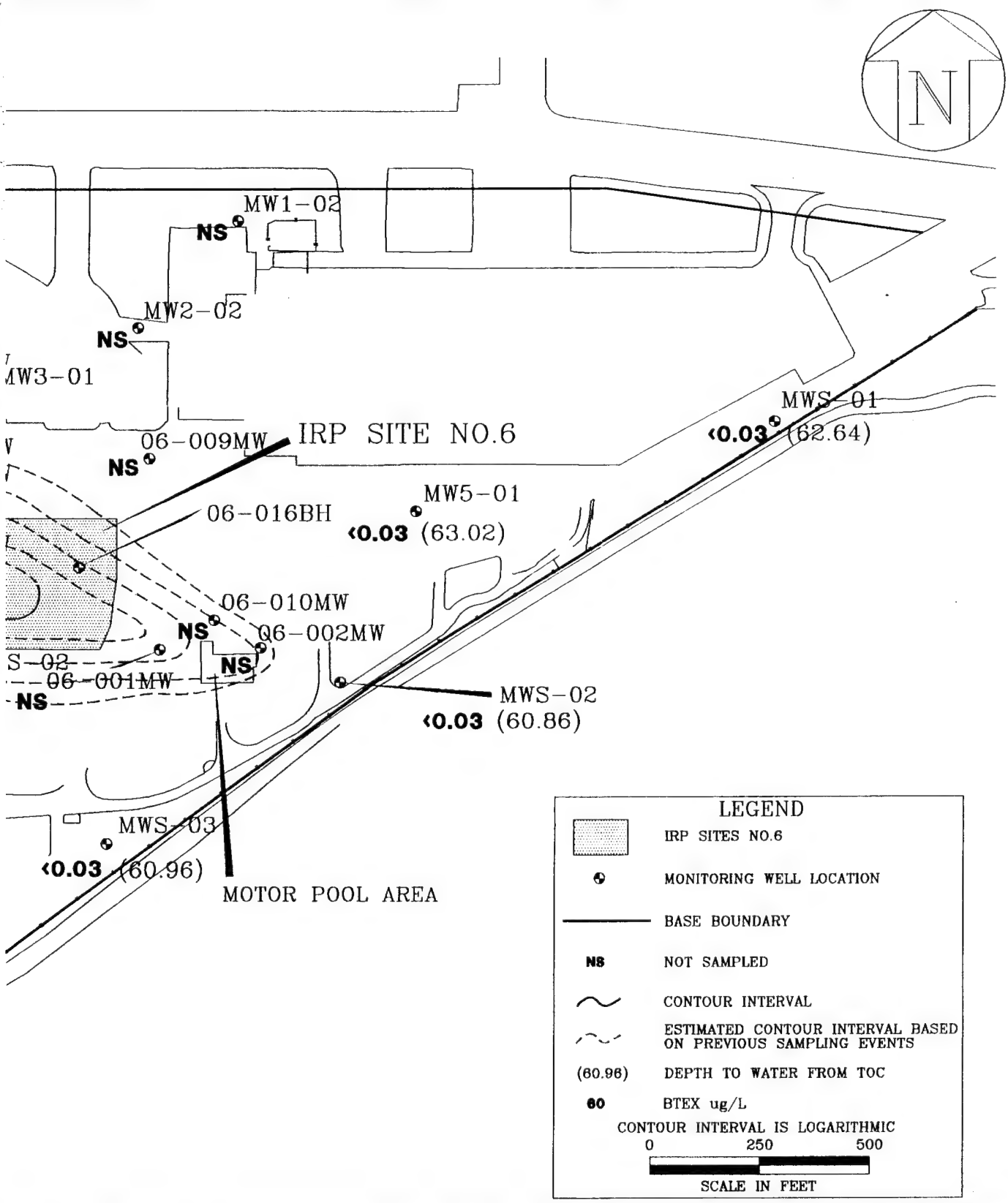
SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 5.9

SKYHARBO\1315-227\MON-TWO

TOTAL BTEX DETECTED IN GROUNDWATER SA

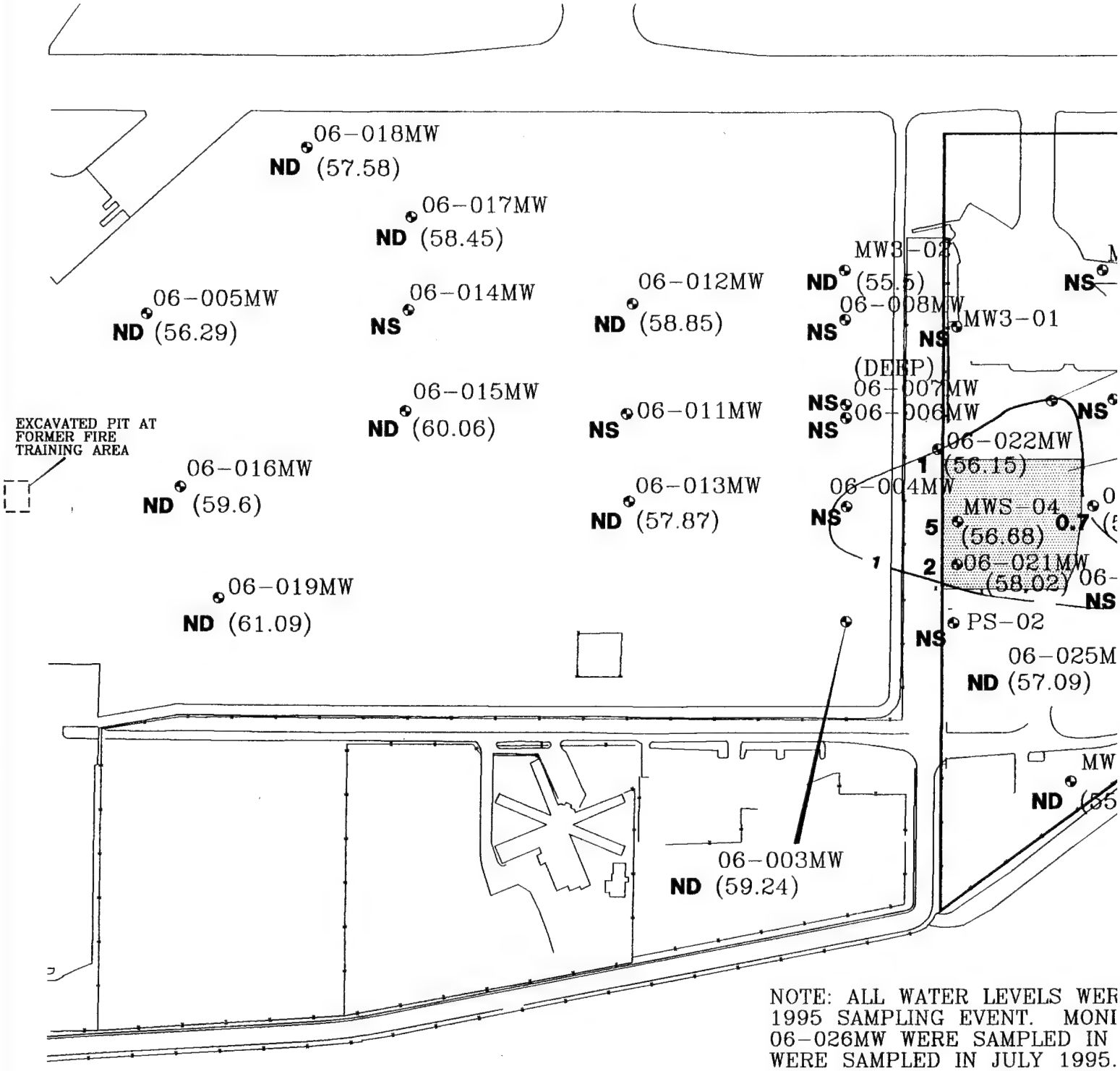
161st ARG, Arizona Air Nat
Sky Harbor Internationa
Phoenix, Arizon



CTED IN JANUARY 1995
ATER SAMPLES
na Air National Guard
ıternational Airport
nix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

MARCH 1996



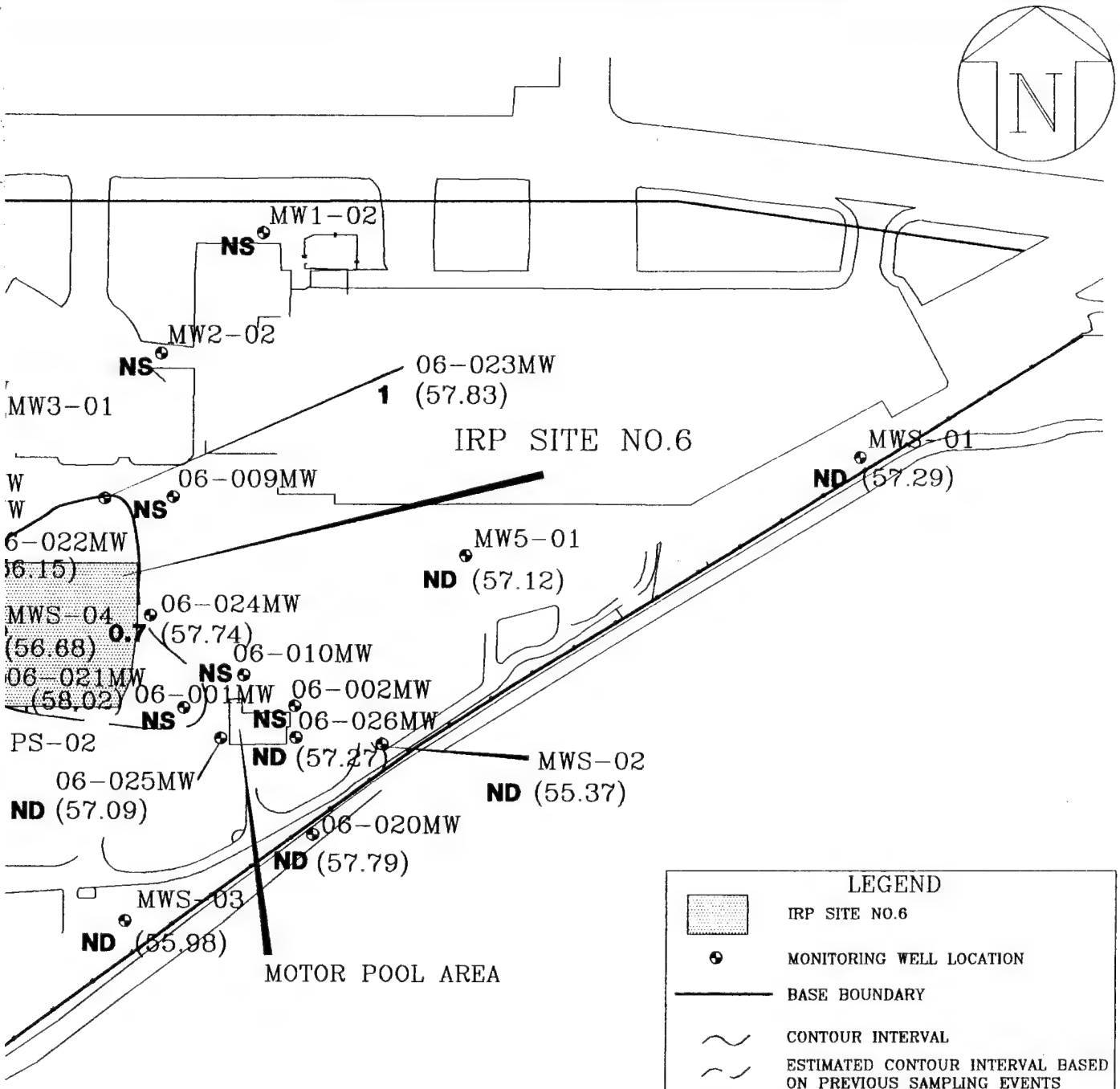
SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 5.10

SKYHARBO\1315-227\MON-3

TPH DETECTED IN SI
(10-14 JULY AND 8-10
GROUNDWATER SA

161st ARG, Arizona Air Na
Sky Harbor Internation
Phoenix, Arizo



LEGEND

- IRP SITE NO.6
- MONITORING WELL LOCATION
- BASE BOUNDARY
- CONTOUR INTERVAL
- ESTIMATED CONTOUR INTERVAL BASED ON PREVIOUS SAMPLING EVENTS
- **ND** NOT DETECTED
- **NS** NOT SAMPLED
- **60** TPH ug/L
- (55.37) DEPTH TO WATER TABLE

CONTOUR INTERVAL IS LOGARITHMIC

0 250 500

SCALE IN FEET

LEVELS WERE RECORDED DURING THE JULY
EVENT. MONITORING WELL 06-018MW THROUGH
SAMPLED IN AUGUST 1995. ALL OTHER WELLS
N JULY 1995.

D IN SIXTH ROUND
) 8-10 AUGUST 1995)
ATER SAMPLES
na Air National Guard
nternational Airport
nix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

MARCH 1996

SECTION 6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 RI ADDENDUM CONCLUSIONS

Conclusions based on the RI and RI Addendum are reported as follows:

- The primary source of the contamination plume downgradient of IRP Site No. 6 is the POL Storage Area which provides the fuel for the refueling mission of the 161st ARG. The contamination detected upgradient of the POL Storage Area is the result of an unspecified source at the motor pool. Contamination from the motor pool area is migrating towards the POL Storage Area and merging with the POL plume.

- The contamination plume is fully defined; however, it does vary in areal extent depending upon the local hydrogeological conditions.

- A conceptual model based upon the RI and RI Addendum has been developed. The conceptual model explains the varying concentrations of contamination detected during the groundwater sampling events. There is an inverse relationship between the water table and concentrations of contamination. In summary, as the water levels decline, the concentrations of contamination generally increase.

- Results of microbiologic analyses indicate low levels of microbiological organisms, soil moisture, and nitrate. Phosphorus and nitrite-nitrogen levels are sufficient to support microbiologic activity. For bioremediation to be a viable remediation option, it would require microbiological augmentation.

- Geotechnical analyses of the soil sample collected from monitoring well 06-023MW at a depth of 39.0 to 40.0 feet BLS was reported as 88.9 percent pebbles and 11.1 percent sand. Sieve analyses of the soil sample collected from monitoring well 06-024MW at a depth of 50.0 to 50.5 feet BLS was reported as 95.3 percent cobble and pebbles, 4.2 percent sand, and 0.5 percent silt and clay. These results indicates both soil samples are a sandy gravel.

- Analyses of soil samples for permeability indicate the soil sample collected from monitoring well 06-023MW at a depth of 39.0 to 40.0 feet BLS was determined

to be 9.73 x 10^{-8} m/sec (9.73 x 10^{-6} cm/sec) and the permeability of the soil sample collected from monitoring well 06-024MW at a depth of 50.0 to 50.5 feet BLS was determined to be 4.42 x 10^{-8} m/sec (4.42 x 10^{-6} cm/sec). According the USDA, this permeability is very low for a sandy gravel (USDA, 1974). Due to the coarse nature of the substrata it was not possible to collect a complete, undisturbed sample. To compensate the laboratory substituted a testing method that used an inch cube "plug" for testing. Due to the plug's small size, the size of the gravels and pebbles in the sleeve, the sample was not representative. Therefore, the values reported are erroneously low.

- Results of the percolation test indicate a high infiltration rate of 448 gal/day/ft^2.

- Twenty-two investigative groundwater samples were submitted for laboratory analysis from the nine newly installed monitoring wells and 13 pre-existing monitoring wells during the July – August 1995 groundwater sampling event. Twenty-two VOCs – benzene, toluene, ethylbenzene, total xylenes, TCE, DCE, PCE, chloroform, carbon tetrachloride, styrene, isopropylbenzene, N-propylbenzene, 1,3,5-trimethylbenzene, 1,1 dichloroethane, 1,2,4-trimethylbenzene, sec-butylbenzene, P-isopropyltoluene, 1,2,3-trichloropropane, N-butylbenzene, hexachlorobutadiene, chloromethane, and naphthalene – were detected in 21 groundwater samples.

- Benzene was detected at concentrations ranging from 0.2 to 4,200 μg/L, exceeding the ADEQ action level of 5 μg/L, in groundwater samples from 17 monitoring wells. Ethylbenzene was detected at concentrations ranging from 0.4 to 750 μg/L, exceeding the ADEQ action level of 700 μg/L in the groundwater sample collected from one monitoring well.

- TCE was detected at concentrations of 0.5 and 7.0 μg/L, exceeding the ADEQ action level of 5 μg/L in the groundwater sample collected from monitoring well 06-016MW. The source of the TCE is unknown; however, east across the Salt River, and upgradient of the base is the Estes Landfill. The Estes Landfill is a site of known TCE and DCE contamination migrating westward in the general direction of the base.

- TPH were detected at concentrations ranging from one to five ppm in groundwater samples collected from monitoring wells MWS-04, 06-21MW,

06-022MW, 06-023MW, and 06-024MW. No ADEQ action level exists for TPH in groundwater.

- Results of laboratory analyses on soil and groundwater samples collected during the RI Addendum indicate no new chemicals of concern or any significant changes in chemical concentrations. Geologic data collected during the RI Addendum indicates no new pathways or potential pathways of exposures. The risk assessment set forth in the RI Report is valid and does not require modification.

6.2 GENERAL CONCLUSIONS

General Conclusions based on the RI and RI Addendum are reported as follows:

- There are two definitive sources of groundwater contamination at the 161st ARG: the POL Storage Area and the vicinity of the motor pool area. Analytical data supports one plume of fuel-related contaminants migrating from the POL area and a second, smaller plume of fuel-related contaminants migrating from the motor pool area. The motor pool plume merges with the POL plume.

- Reported fuel releases from transfer lines have resulted in groundwater contamination, identified as a plume migrating from the POL area in a west-northwest direction. This plume has a large areal extent and in characterized as containing high concentrations of BTEX.

- Releases from an unspecified source in the motor pool area have also resulted in a groundwater contamination plume migrating in the same direction as the POL plume. Primary constituents of this plume are also characterized as high concentrations of BTEX. Due to its geographical location (upgradient) of the POL Storage Area, this plume is merging with the POL plume.

- There is also an indication of an off-base, upgradient source most likely originating from across the Salt River. Directly east of the 161st ARG, across the Salt River is an industrial area. Located in this industrial area is the Estes and Bradley Landfills, the Tanner Company, and the Southbank Lake. At these sites, contamination consisting primarily of chlorinated solvents such as TCE,

DCE, as well as benzene have been reported. This assumption is based upon analytical data from the background monitoring wells and hydrogeologic data.

Conceptual Model

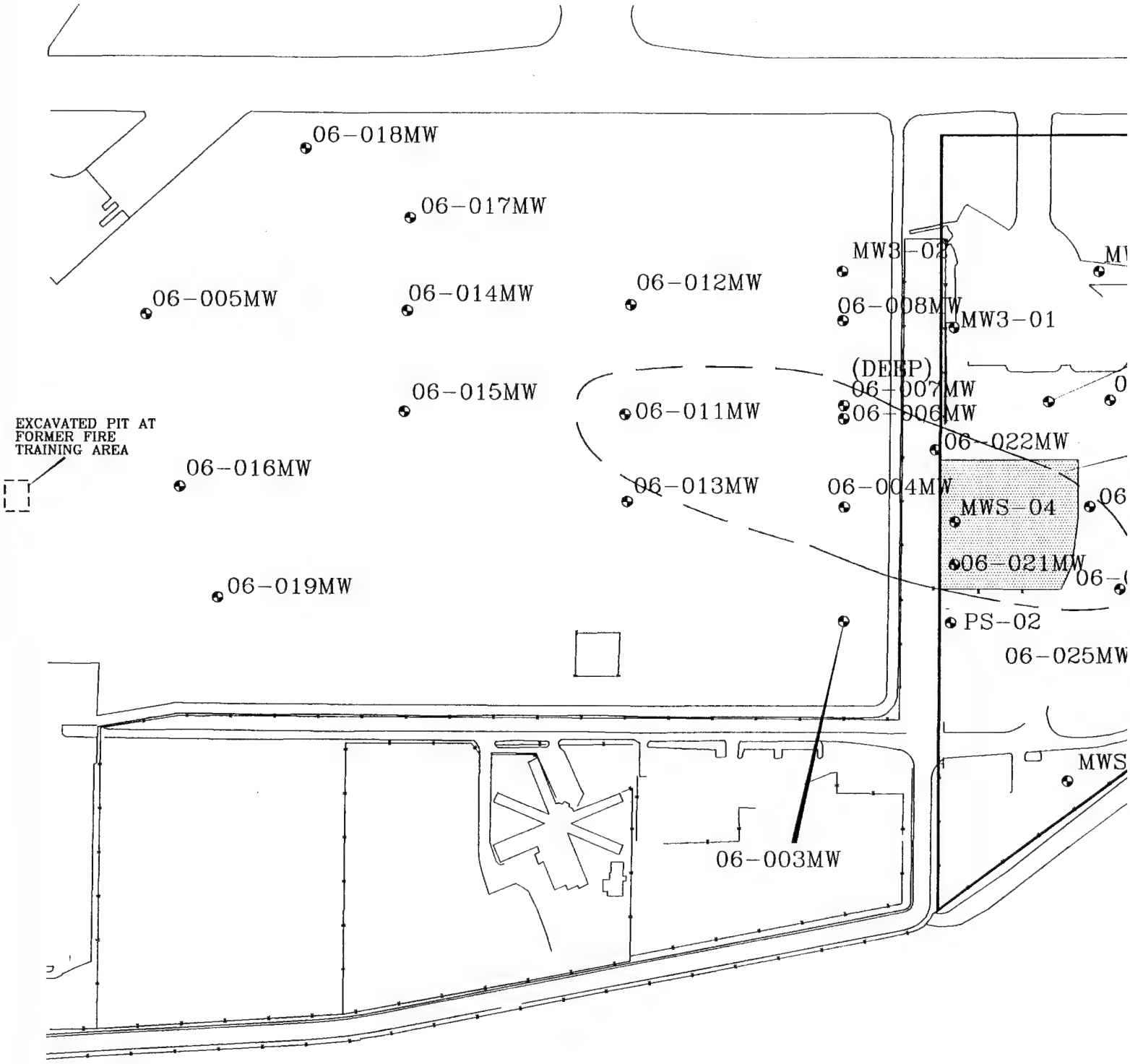
Fuel has been leaking out of the POL system for an unknown length of time. As the fuel has migrated downward through the soil column portions have been absorbed by the soil. Due to leakage over a long period of time, the soil interval between the leaking source and the water table becomes saturated and contamination impacts the groundwater.

As the supply of contamination becomes greater than the rate of dispersion, lighter than aqueous phase liquid pool on the surface of the groundwater and migrate downgradient on a plane parallel to the water table. If the rate supply of contamination is less than the rate of dispersion, the contamination disperses into the groundwater and begins to migrate with the groundwater. As the contamination migrates either in the groundwater or on top of the groundwater, it comes in contact with soil particles and begins to absorb to the particles.

As the contamination is migrating, the water table is fluctuating vertically. As a result, the contamination is distributed vertically and absorbs to soil particles. The result is a zone of a residue of secondary contamination referred to as the smear zone. With time the smear zone migrates and expands vertically, depending upon the water table fluctuations and supply of contamination, and horizontally, depending upon groundwater flow and a continuing supply of contamination.

Monitoring well lithologic logs indicate that within this smear zone, lithology varies from gravels to sands with varying amounts of clays, silts, and very fine sands. Contamination will adhere to finer material in larger amounts because the finer materials have more surface area. Based upon GC analyses of soil samples collected while drilling, the smear zone was observed in monitoring wells 06-004MW, 06-006MW, and 06-007MW which are located directly downgradient of the POL Storage Area. Based upon this data, the thickness of the smear zone is approximately 20 feet. The estimated areal extent, base upon gas chromatograph analysis of soil samples, is depicted on Figure 6.1.

Record rainfall levels in the Phoenix area during Fall 1992 and Spring 1993 resulted in record high water levels during the first round of groundwater sampling conducted in September 1993. Groundwater fluctuations of 19 feet have been recorded during the RI and RI Addendum.



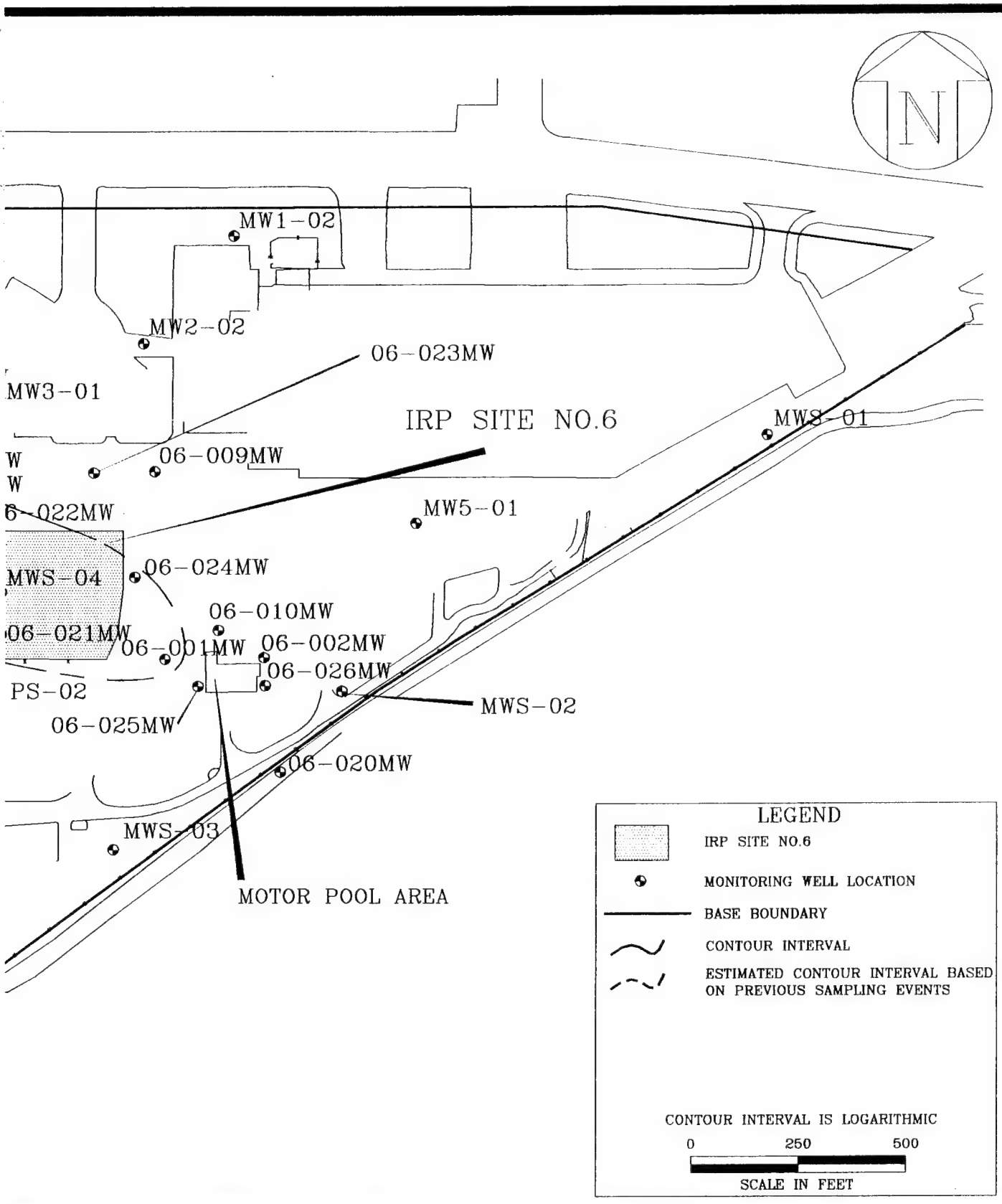
SOURCE: MODIFIED FROM SKY HARBOR INTERNATIONAL AIRPORT ENGINEERING DEPARTMENT

FIGURE 6.1

SKYHARBO\1315-227\MON-3

ESTIMATED AREAL E
OF SMEAR ZON

161st ARG, Arizona Air Nat
Sky Harbor Internationa
Phoenix, Arizon



AREAL EXTENT
NEAR ZONE

ona Air National Guard
nternational Airport
enix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

APRIL 1996

Monthly records from an airport monitoring well located 330 feet west of monitoring well 06-016MW indicate that groundwater fluctuations in the area may be 10 to 12 feet greater than what has been record from ANG monitoring wells.

Water levels were at their highest during the September 1993 sampling event and at their lowest during the July 1994 sampling events. During these two sampling events, concentrations of contamination were at their lowest. During the February 1994, April 1994, and July-August 1995 sampling events, groundwater levels were declining. Concentrations of contamination in groundwater samples from these sampling events were higher. In summation, the data supports an inverse relationship between the fluctuations in the water table and concentrations of contaminants. As the groundwater declines through the smear zone, contamination will desorb from the soil particles and disperse into the groundwater and migrate downgradient with the groundwater flow. As groundwater migrates, contaminants will begin to disperse laterally. There is no analytical data available when groundwater levels were rising; therefore the effect of the water table rising through the smear zone is unknown.

6.3 RECOMMENDATIONS

Recommendations based on the conclusions of the RI Report and this RI Addendum Report are as follows:

- There is no consistent monthly water level data at the 161st ARG. The Environmental Office should collect water level data from several wells on a monthly basis.

- The quarterly groundwater sampling program at the 161st ARG should be continued.

- An FS should be completed on IRP Site No. 6 to determine the best remedial alternatives for Remedial Action.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 7.0 REFERENCES

Arizona Department of Environmental Quality, 1990. "Human Health-Based Guidance Levels for Contaminants in Drinking Water and Soil," Phoenix, Arizona, Draft Guidelines.

Arizona Department of Health Services, ADHS BLS-181 Method, Phoenix, Arizona.

Bales, J. T., Wellendorf, C. S., and Pewe, T. L., 1986. "Environmental Geology of the Tempe Quadrangle, Maricopa County, Arizona, Ground Water Map," Geologic Investigation Series Map GI-2-F, Arizona Bureau of Geology and Mineral Technology, Tucson, Arizona.

Brown, J. G., and Pool, D. R., 1989. "Hydrogeology of the Western Part of the Salt River Valley Area, Maricopa County, Arizona," U. S. Geological Survey Water-Resources Investigations Report 88-4202, Tucson, Arizona.

Demsey, K. A., 1989. "Geologic Map of Quaternary and Upper Tertiary Alluvium in the Phoenix South 30' x 60' Quadrangle, Arizona, Arizona Geological Survey Open File Report OFR 89-7," Tucson, Arizona.

Fenneman, N. M., 1931. "Physiography of the Western United States," McGraw-Hill, New York, New York.

Hazardous Materials Technical Center, 1988. "Preliminary Assessment, 161st Air Refueling Group, Arizona Air National Guard, Sky Harbor International Airport, Phoenix, Arizona."

IT Corporation, 1992. "Draft Final Site Investigation Report, 161st ARG, Arizona Air National Guard."

Operational Technologies Corporation, 1995. "Remedial Investigation Report for IRP Sites No. 6 and No. 7, 161st Air Refueling Group, Arizona Air National Guard, Sky Harbor International Airport, Phoenix, Arizona."

Pewe, T. L., Bales, J. T., and Wellendorf, C. S., 1986. "Environmental Geology of the Temple Quadrangle, Maricopa County, Arizona, Geologic Maps," Geologic Investigation Series Map GI-2-A-B-C, Arizona Bureau of Geology and Mineral Technology, Tucson, Arizona.

Ruffner, J. A. and Bair, F. E., 1987. "Weather of U. S. Cities," Gale Research Company, Detroit, Michigan.

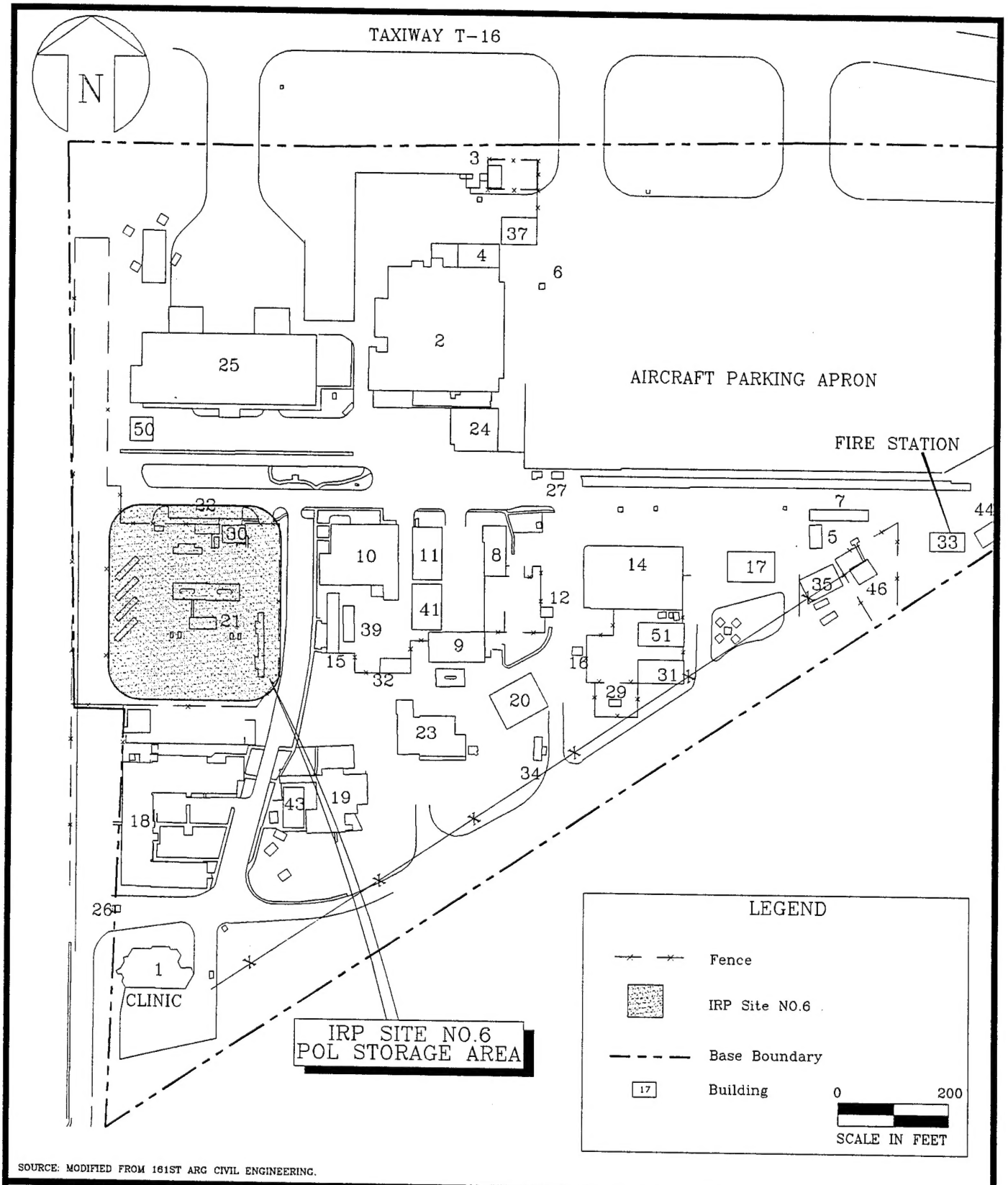
Trosi, F., Arizona Department of Environmental Quality, June, 1995. Personal Communication, Phoenix, Arizona.

U. S. Bureau of Reclamation, 1977. "Geology and Groundwater Resources Report, Maricopa and Pinal Counties, Arizona – Central Arizona Project," Vols. 1 and 2, Washington, D. C.

U. S. Department of Agriculture, 1974. "Soil Survey, Eastern Maricopa and Northern Pinal Counties Area, Arizona," USDA Soil Conservation Service, Washington, D. C.

U. S. Environmental Protection Agency (USEPA), 1979. "Methods for Chemical Analysis of Water and Wastes," (EPA-600/4-79-020) and as amended in 1982 (USEPA-600/482-055).

U. S. Environmental Protection Agency (USEPA), 1986. "Test Methods for Evaluating Solid Waste," (EPA/SW846), Third Edition.



SOURCE: MODIFIED FROM 161ST ARG CIVIL ENGINEERING.

INSIDE BACK COVER

SKYHARBO\SKI1-2IR

LOCATION OF IRP SITE NO.6 PETROLEUM, OIL, AND LUBRICANT STORAGE AREA

161st ARG, Arizona Air National Guard
Sky Harbor International Airport
Phoenix, Arizona

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

APRIL 1986